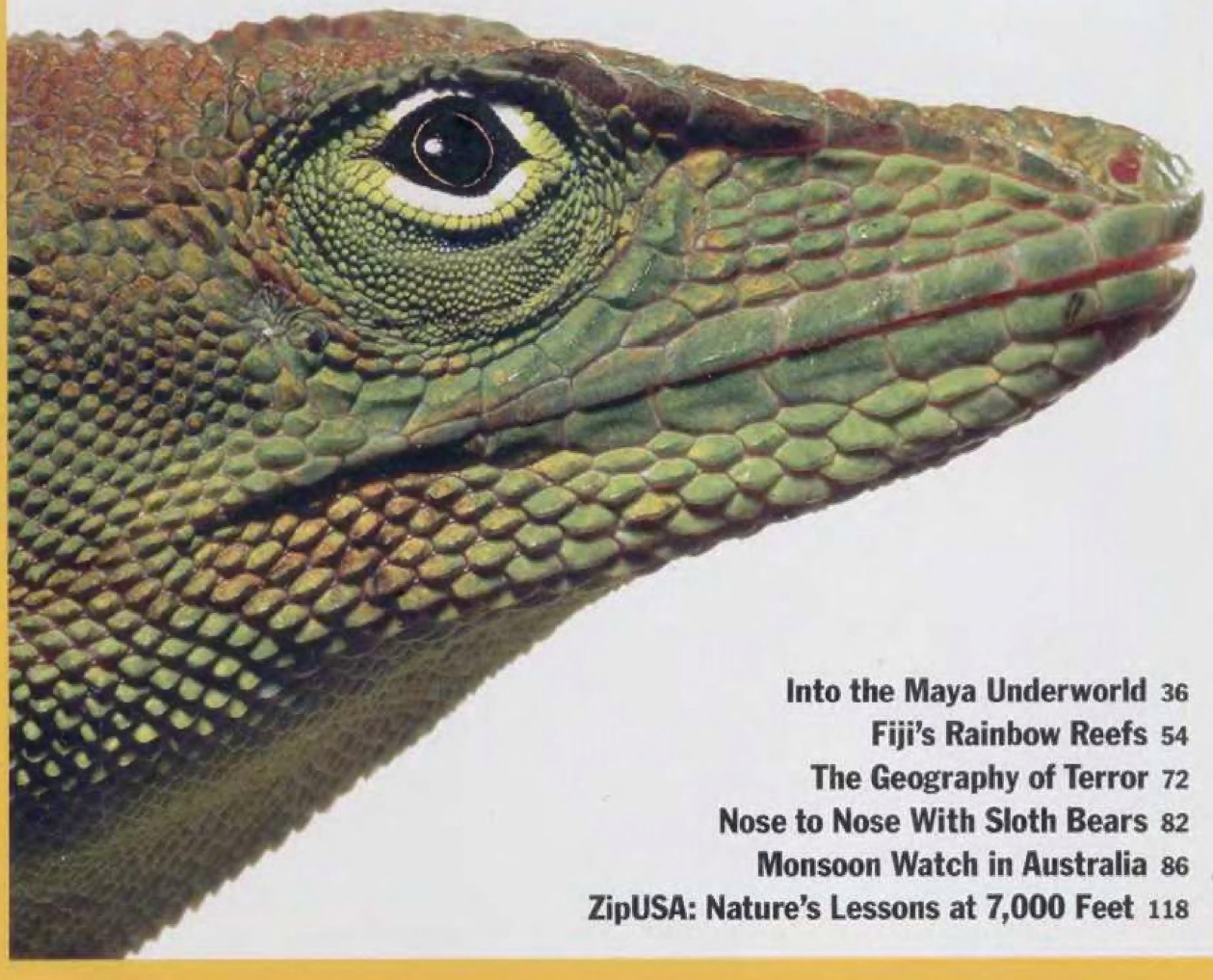
NEW MAP OF THE WORLD

NATIONALGEOGRAPHIC.COM/MAGAZINE NOVEMBER 2004

NATIONAL GEOGRAPHIC

WAS DARWIN WRONG?



VOL. 206 • NO. 5 • NOVEMBER 2004

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DEPARTMENTS

THE COVER
The unique traits of a Jamaican lizard illustrate Darwin's theory.
BY ROBERT CLARK

Cover printed on recycled-content paper

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When things go bad, they go very, very bad for members of risky expeditions. Relive the fateful choices that resulted in the fall of climbers into a crevasse on Oregon's Mount Hood and see their perilous rescue (left). Witness the amazing survival story of a marathon runner in the Sahara. And experience other exciting expeditions that take you right up to the edge of danger.

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Re-create the scene as a truckful of explosives ravages a nine-story building, killing 168 people in mere seconds. Tune in for an in-depth examination of the 1995 terrorist bombing of the Alfred P. Murrah Federal Building in Oklahoma City. Dissecting the details of catastrophe, from an airliner crash to a deadly tunnel fire, this innovative series continues its investigation of the fleeting events that can add up to tragedy.

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WEDNESDAYS
10 P.M. ET/PT

Naked Science

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Channel and NGT&F programming information accurate at press time; consult local listings or the Society's website at nationalgeographic.com

NG Television & Film

NATIONAL GEOGRAPHIC SPECIAL, PBS
NOVEMBER 10, 8 P.M. ET

Last Full Measure

Rituals of patriotism and honor unfold daily at Arlington National Cemetery, burial ground of Presidents and privates. Share in the stories of those resting here, from astronauts to freed slaves. And meet the protectors of Arlington, including soldiers of the old guard (left), who help perform the funerals at this American shrine.

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DARWINIAN EVOLUTION
INTERACTIVE PHOTO SHOOT See Robert Clark's "Was Darwin Wrong?" come to life. ■ **FIELD NOTES** How he shot 23 locations in six countries in six weeks. ***nationalgeographic.com/magazine/0411***

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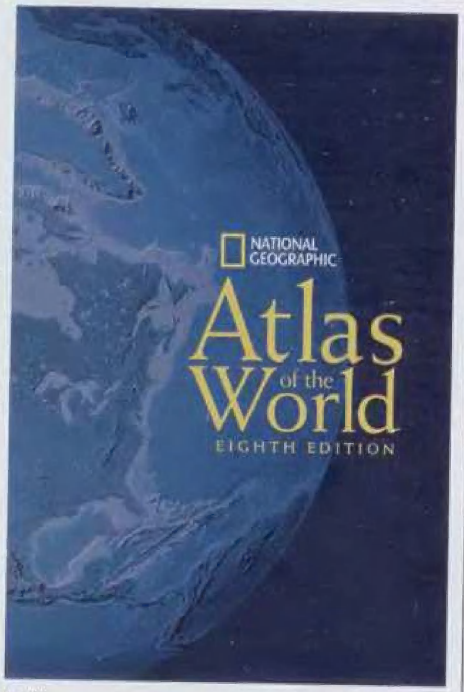
FROM TOP: DON RYAN, AP PHOTO; AP PHOTO; LAURA DICKSON, NGT&F; ROBERT CLARK

Behind the Scenes

ATLAS

The World Has Changed



Say the word "atlas," and many people think of a collection of country maps. But that's an oversimplification, says National Geographic Chief Cartographer Allen Carroll. "The real world is much messier and much more interesting." That's why the new eighth edition of the *National Geographic Atlas of the World* goes beyond the boundaries of just showing boundaries. Using improvements in geographic information systems and digital publishing, our cartographers have illustrated such complex concepts as ecoregions (below), epicenters of earthquakes, and population densities. New sections of the eighth edition show human migration patterns, areas of conflict, and health and literacy levels. With imaging from satellites and space probes, the atlas features an updated map of city lights splashed across Earth at night, as well as maps of the surface of Mars and of the universe itself.

Even traditional political maps have gone through a metamorphosis since our seventh edition atlas was published in 1999. Some 17,000 updates on 71 political maps reflect events ranging from upheaval in Somalia to the shrinking of the Aral Sea. Our map of Greece, for example, required 1,199 changes when Greek officials modified the spelling of certain place-names there. "We used to revise the atlas only every ten years, but we can't do that anymore," says Allen. "We have a planet to keep up with." The eighth edition *National Geographic Atlas of the World* is available from *nationalgeographic.com* or wherever books are sold.

MARK THIESSEN, NGS (BOTH)

NGS Calendar

October

"Another Vietnam" exhibit. See images of the Vietnam War taken by photographers from North Vietnam. Through Jan. 16 at the Maxwell Museum, Albuquerque, N. Mex.

22-24 All Roads Film Festival. Indigenous and minority-culture filmmakers tell their stories at the Egyptian Theatre, Los Angeles, Calif.

28 "Mapping With Paper and Pixel" exhibit continues through Feb. 13, 2005. Explore the richness of mapping technology. National Geographic, Washington, D.C.

28-30 All Roads Film Festival, National Geographic, Washington, D.C.

November

Last month to see *Forces of Nature* film at giant-screen theaters in San Diego, Calif., and St. Paul, Minn.

17 Cartographic lecture with National Geographic Chief Cartographer Allen Carroll and map technology expert John Calkins. Learn about the making of the new *National Geographic Atlas of the World.* National Geographic, Washington, D.C.

18 Explorer Helen Thayer lectures about her book *Three Among the Wolves* at National Geographic, Washington, D.C.

19 Universe of Dreams Celebrate stories about the universe with images from Hubble Space Telescope and music of Ensemble Galilei. Program narration by NPR host Neal Conan at National Geographic, Washington, D.C.

NATIONAL GEOGRAPHIC MAPS

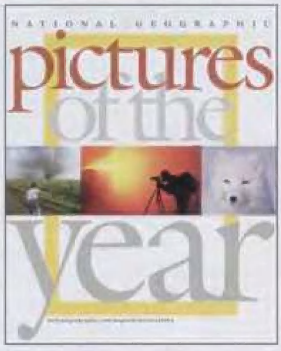
Guiding Light

When Marine Corps Staff Sgt. Jerome Boganowski was sent to Iraq with his reserve unit, he decided to take along our October 2002 Middle East supplement map. It came in handy. His job in Iraq was directing convoys to military bases, but he had no maps along to guide him. "Several times," he says, "we didn't know where we were." Jerome logged 3,000 miles on the road during three months in the desert, navigating with a GPS unit from home and his NATIONAL GEOGRAPHIC map. "I never let the map out of my sight," he says. "It was a godsend." Now back at his old job as an Omaha, Nebraska, deputy sheriff, Jerome has laminated the well-worn map and hung it in a place of honor on his wall.

NEW RELEASE

Pictures From the Planet

What did 2004 look like? In NATIONAL GEOGRAPHIC it looked like Shiite Muslim pilgrims at a holy shrine in Iraq, a tornado scouring the midwestern landscape, swimming elephants, and more. Our special edition *Pictures of the Year* features images from the 84 stories the magazine published this year to provide a record of the world in 2004—its curiosities, calamities, and grandeur. Available at newsstands, bookstores, and online at *nationalgeographic.com/magazine/pictures2004*.



AUSTRALIA'S MONSOON (PAGE 86)

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November

30 *Return to Titanic* book signing and presentation with underwater explorer Robert D. Ballard at National Geographic, Washington, D.C.

December

9 Photographer Chris Rainier lectures on his book *Ancient Marks*, sharing stories and pictures from his years documenting different body-art practices around the globe. National Geographic, Washington, D.C.

10 Celtic Christmas Musical Celebration Traditional band Boys of the Lough provides a musical journey through the midwinter and Christmas traditions of Scotland, Ireland, and England's Northumberland at National Geographic, Washington, D.C.

Calendar dates accurate at press time; go to *nationalgeographic.com* or call 1-800-NGS-LINE (647-5463) for more information

Ask Us

What can I do with all my old NATIONAL GEOGRAPHICS? I'd hate to throw them out. Your local schools, nursing and retirement homes, hospitals, and prisons might accept GEOGRAPHIC donations, but call first to be sure. Many groups send magazines overseas to help teach English. Contact Books for Africa *(booksforafrica.org)*, Book Aid International *(bookaid.org)*, or the Asia Foundation *(asiafoundation.org)*.

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MICHAEL FORSBERG (TOP)

THROUGH A PHOTOGRAPHER'S EYES

Visions of Earth

BRAZOS RIVER, TEXAS

Natural disasters have always fascinated me—their scale, the way they change the whole look of nature—so when I was living in Houston one winter and heard the Brazos had flooded, I hired a pilot to fly me to the river. I spotted this drowned orchard and thought, Wow. We kept working it, flying in tighter and tighter circles. Right in the middle of the shoot, for three or four frames, everything lined up in a graphic pattern that told the story. *—Cameron Davidson*

Decorate your desktop with this image of the Brazos in flood at nationalgeographic.com/magazine/0411.

From the Editor

Humans are not descended from apes.

But then Charles Darwin never claimed we are. Still, his ideas were misconstrued and lampooned from the beginning, as in the 1878 cartoon below. What Darwin actually said was that the myriad species inhabiting Earth are a result of repeated branching from common ancestors—a process that came to be called "evolution." The mechanism of evolution, Darwin's "natural selection," determines how plants and animals come to look and behave as they do.

© ARCHIVO ICONOGRAFICO, S.A./CORBIS

Today both terms are still misunderstood.

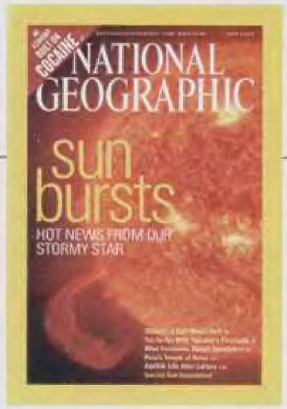
Some of the confusion stems from the phrase the "theory of evolution." When scientists say "theory," they mean a statement based on observation or experimentation that explains facets of the observable world so well that it becomes accepted as fact. They do not mean an idea created out of thin air, nor do they mean an unsubstantiated belief.

Our magazine aims to explore the world, often by highlighting scientific concepts such as evolution. Is this approach necessarily at odds with faith, which lies beyond the possibility of scientific proof? No. Just as religion did not disappear after Galileo demonstrated that the Earth is not at the center of the solar system, evolution does not exclude God from our origins, the "mystery of mysteries"—a 19th-century astronomer's description borrowed by Darwin himself.

Beginning on page 2, David Quammen explains how scientists, by using techniques unheard of in Darwin's time, are finding more evidence than ever of the evolutionary links among all living things. The photographs by Rob Clark allow us to appreciate Darwin's genius—and, in a sense, to imagine that we are seeing and thinking like Darwin, with new patterns unfolding before our eyes.

Bill Allen

Forum



July 2004

"Cocaine Country," our story about the relationship between coca growers and insurgents in Caquetá, Colombia, elicited a strong response from Colombians. A number of them described the progress in curtailing Colombia's drug trade. (While the cover shown here was on subscriber copies, the cocaine story was on the cover of half the newsstand copies in North America and on most copies sold overseas.)

Cocaine Country

The reporting for your article, which started in December 2000, does not accurately portray what is taking place today in Caquetá and numerous other communities across Colombia. According to the United Nations, Colombia's coca crop was reduced by 47 percent from December 2000 to December 2003. Moreover, in the state of Caquetá, the coca crop was reduced by 72 percent from August 2000 to December 2003. Through a U.S.-Colombian partnership begun in 2000, the government of Colombia is working to reach every community with alternative development and other social programs to help coca and poppy farmers transition to legal economic activities. Since 2001 Colombia and the U.S. have cooperated to support the cultivation of 45,456 hectares [175 square miles] of legal crops. The Colombian government is committed to destroying the cocaine industry in every region, combating all actors—both guerrilla and paramilitary—engaged in drug trafficking and terrorism, and providing relief to affected populations. We have by no means resolved all our problems, but sadly your article fails to acknowledge the dramatic improvement realized in the last few years.

LUIS ALBERTO MORENO
Ambassador to the United States
Embassy of Colombia
Washington, D.C.

The camera may never blink, but indiscretion and the omission of material facts will blur a picture beyond recognition. Contrary to what you represented in "Cocaine Country," the FARC [Revolutionary Armed Forces of Colombia] is an unrepentant and ruthless drug cartel. It controls a heroin and cocaine trade worth between 250 million and 600 million dollars a year. The FARC is on the State Department's list of terrorist groups. It is also on the Treasury Department's list of narco-terrorist organizations. Americans are banned from doing business with FARC members. Its leadership has been

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My Seven

The Apollo 17 astronaut Harrison Schmitt's doomsday worry of an asteroid attack as justification for space exploration is as reasonable as building huge walls on all our coasts to protect us from tidal waves. It might have merit, but at what cost? And if space travel, mining, development, and tourism are such great ideas, let private enterprise foot the bill and reap the rewards.

DAVE HOLAWAY
Eagar, Arizona

I was thoroughly fascinated by Harrison Schmitt's seven reasons for going back to the moon. Indeed, I would have liked to have read more about his vision for our future in space, especially as it applies to Earth. Schmitt's number one reason, utilizing helium 3 for fusion power, holds enormous possibilities for terrestrial use, as well as for interplanetary exploration and settlement.

WILLIAM F. MELLBERG
Park Ridge, Illinois

NASA

I do not believe we have the right to mine the moon, no matter how low it will bring the costs for moon tourists. If our species cannot survive on this planet, which gave us life, then why do we deserve any other body in our solar system or anywhere else for that matter?

KIMBERLY HUFF
Gainesville, Florida

Before we embark on a mission to mine helium 3 or anything else on the moon's surface, we should clean up Mother Earth and take care of all her starving children and endangered species. It is a sad state of affairs when millions of dollars are spent on space exploration so that 20 percent of Earth's population can enjoy the spectacle, while the other 80 percent are stuck somewhere in the Dark Ages of disease, war, poverty, and starvation.

HELEN STEC
Calgary, Alberta

indicted for murder by the Department of Justice. When FARC reaches its final resting place on history's ash heap, it will be remembered for atrocities, not altruism; for community destruction, not community redemption. No credible source, left, right, or center, will argue the point.

ROBERT B. CHARLES
Assistant Secretary of State
Bureau for International Narcotics and Law Enforcement Affairs
U.S. Department of State
Washington, D.C.

It is undeniable that the FARC has committed and continues to commit unspeakable violence against the people of Colombia and foreigners. But to charge that NATIONAL GEOGRAPHIC *glorifies the FARC and in doing so seeks to portray a somehow softer side of cocaine is to misconstrue our story, which begins unequivocally, "A drug that devastates lives around the globe also afflicts the remote province of Caquetá." What we put forth for our readers is another element in the complicated and often tragic situation surrounding the growing and selling of coca. In Caquetá the farmers that our writer met believe they have no viable alternative but to participate in the backwater economy ruled by cocaine.*

Our article draws into sharp focus what is actually happening in these villages and reveals subtle details and complexities that are too often neglected.

BILL ALLEN
Editor

I want to thank your magazine and Carlos Villalón for bringing up the issue of the real problem that our country is facing.

JORGE CARDENAS
Bogotá, Colombia

Economics 101 teaches us that as long as the demand exists, society will find a way to satisfy that demand, even when the means are illegal and fraught with damage for the society itself. It's stupid for U.S. policy to expect subsistence farmers to turn away from the most profitable crops.

MARK LAMPS
Qingdao, China

FROM OUR ONLINE FORUM
nationalgeographic.com/magazine/0407

WRITE TO FORUM National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and length.

Sun

Your pictures of the sun were beautiful, and the text captured the majesty of solar events. If students were taught about the sun and other topics in such a captivating way, they would more easily grasp the beauty and truth of what the science is describing.

JACOB OLSON
Valley Stream, New York

One question: How are photos taken of the sun without the lens burning?

DONALD HUNT
Virginia Beach, Virginia

There are several ways to beat the heat. Some satellite telescopes have aluminum filters that block visible light so that little solar heat reaches the inside of the telescope. Others divert heat to a secondary mirror, then along pipes to the frigid side of the satellite facing away from the sun.

Your article mentions that periods of time when there is little or no sunspot activity appear to cause a significant increase in carbon-14 levels. A question: With carbon 14 being used for determining the age of a great many things, would this cause the carbon-14 dating system to be variable and less accurate? Could the lack of information recorded in the past about the occurrence of low sunspot activity also cause an error in the calculations?

DOUGLAS LEMONS
Port Saint John, Florida

Carbon-14 dates are calibrated to account for variations caused by phenomena such as solar activity, nuclear weapons testing, volcanic activity, and fossil fuel combustion. Variations during the past 50,000 years have been identified by checking C 14 against tree-ring chronologies and carbon from organic material in annual layers of marine and lake sediments.

When the FARC insurgents reach their final resting place on history's ash heap, they will be remembered for atrocities, not altruism; for community destruction, not community redemption.

Olympic National Park

The opinion expressed by the park superintendent about how the park should be managed is outdated. The park, he says, "doesn't belong to the Park Service or the federal government. It belongs to the American people." Nowadays, any person involved in nature conservancy should approach the problem the same way a watch factory presents its product: You never actually own it, you merely look after it for the next generation.

GIANCARLO MELANO
Turin, Italy

I first started hiking and climbing in Olympic National Park in 1946. Once visited by few, it has slowly gained recognition. Still, one can see elk, bears, deer, mountain goats, cougars, eagles, weasels, marmots. No longer a best kept secret due to its limited trailhead access, it is slowly succumbing to the beer can and candy wrapper crowd. I hope that the National Park Service will show the wisdom to keep the park as it is: one of the last pristine parks in the lower 48.

AL ROUSSEAU
Seattle, Washington

Wind Scorpions

I was very much amused by your story about wind scorpions. As a former GI who served in the Persian Gulf war, I had my own personal dealings with those little varmints, and I can testify that they're painful biters. However, thank the Lord for combat jump boots. Those and quick reflexes kept me from being nipped by the critters. Thanks for the great information. Perhaps other soldiers will read the story before they are deployed, and it might prevent them from having a nasty episode with this interesting animal.

SHELDON RICE
Columbia, South Carolina

Geographica: Global Food Fight

It seems that the EU means business about allowing a product to have a geographic name only if it is made in that place. But, how far will they take it? Should I think twice over the legality of making myself a sandwich for lunch? Can that now only be done in England? The foods have assimilated into cultures across the globe. It's a bit silly to claim ownership of them now.

JILL FOSTER
Whitakers, North Carolina

WORLD POLITICS

A Vote for Democracy

It takes more than elections to make it work

Just two centuries ago most of the world was ruled by monarchs, and voting was a rare privilege. Even in the United States, the first modern democracy, voting was generally restricted to white men who owned property.

French political thinker Alexis de Tocqueville, though, was convinced an "irresistible revolution" toward equality was under way. He believed it had progressed the furthest in the U.S., which he visited in the 1830s to see the future of humankind. Yet by the close of the 19th century, universal suffrage—the right for each person to vote—was far from becoming a reality.

Enter the 20th century.

Following World War I, as monarchs and empires fell and women's suffrage gained momentum, people across the Northern Hemisphere were granted the vote. In the Southern Hemisphere independence came to European colonies after World War II; with nationhood came, gradually, the right to vote. By last spring, when black South Africans in Pretoria lined up to vote in their third presidential election (below), universal suffrage had spread across the globe (map).

But suffrage is one thing. Ensuring that elections are free, fair, and competitive—the minimum threshold that political scientists set for democracy—is another. And liberal democracy, the kind many Western nations enjoy, requires even more: free speech, a free press, and the rule of law. The good news is that while democracy has lagged behind the right to vote, it's also on the rise. Experts say we're in the midst of a wave of democratization fueled by economic development, increased education, the emergence worldwide of a middle class, the growing reach of free markets, and technological advances that have carried the news of democracy to most people on Earth.

Today, of the world's 192

History of Voting Rights

Date when all citizens were first granted the right to participate in the electoral process

- Since 1980
- 1960-1979
- 1940-1959
- 1920-1939
- Before 1920

- Women got the vote 50 to 100 years after men
- Women got the vote more than 100 years after men
- Voters have one party to choose from

RUSSIA
Though Russia granted universal suffrage after the overthrow of the tsar in 1917, the right to vote had little meaning under communism.

SWITZERLAND
Women did not get the right to vote until 1971.

IRAN
The voting age is 15, the youngest in the world.

BHUTAN
Village leaders ask family heads to approve national assembly candidates, often chosen by government authorities.

BRUNEI
No legislative elections have been held since 1965.

GULF STATES
In 1998 Qatar gave women the same limited voting rights as men. Last year Oman allowed all citizens to vote for the first time for a consultative council. This month Saudis vote for the first time in countrywide municipal elections. In Kuwait women can't vote, and only 10 percent of men are eligible.

CENTRAL AFRICAN REPUBLIC
Since a 2003 coup, elected government has been suspended, but plans are under way for multiparty elections and a return to civilian rule.

SOUTH AFRICA
Blacks did not have the right to vote until 1994, with the end of apartheid.

SWAZILAND
Legislative elections are held, but only for monarch-endorsed candidates.

NEW ZEALAND
The island nation was the first to give women the vote, in 1893.

MAP SOURCES: FREEDOM HOUSE; INTER-PARLIAMENTARY UNION
NATIONAL GEOGRAPHIC MAPS
PHOTOGRAPH BELOW: ANDREW SILK, ZUMA/CORBIS

countries, 117 are considered electoral democracies, according to Freedom House, which promotes democracy worldwide. But there is no one model for a working democracy. Voter turnout, for example, varies greatly (below), and analysts argue over its meaning. Does low turnout mean voters are satisfied—or alienated to the point of apathy? Does high turnout mean voters are engaged by issues and candidates—or that a regime like the one in Belarus is forcing some citizens to the polls to create an impression of legitimacy? Female representation in elected bodies is another thorny issue. Typically, it falls far short of the percentage of women in the population, coming close only in places like Rwanda and the Nordic nations (below right), where political parties or laws require that a percentage of candidates be female.

Political scientist Francis Fukuyama wrote at the end of the Cold War that we had reached the "end of history," with liberal democracy and capitalism the only viable systems left for states that want to be modern. Now, 15 years later, things don't look so simple. The future may bring different versions of democracy as the system is accepted in nations with non-Western cultures.

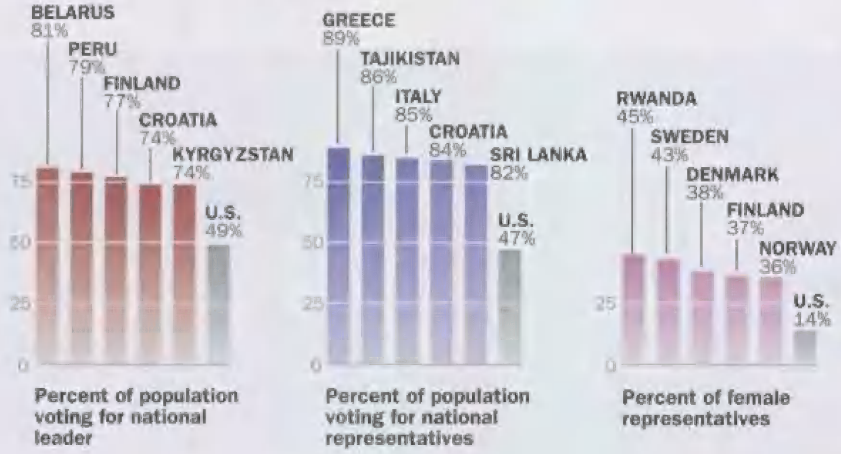
B & C ALEXANDER

Bruce Gilley, author of *China's Democratic Future*, predicts democracy will come to that country as reformists in its leadership respond to pressure from below. Chinese scholars are already considering things they think will improve democracy—such as methods other than elections to give citizens a voice in shaping government policies.

And some countries now in transition between an old form of government and democracy may never get there at all. In certain instances, says scholar Thomas Carothers, opposing political elites, considered corrupt and self-interested by average citizens, simply trade control of government through elections, without tackling their nations' problems. In others, dominant parties manipulate elections to remain in power. This year in Russia the government went to great lengths to ferry ballot boxes by helicopter to Siberian camps so reindeer herders could vote (above). Yet it also kept tight control of the media, and some critics charge that the government chosen by Russian voters amounts to no more than an "elected autocracy."

Experts agree democracy is the system that offers the best hope of promoting individual rights. However, in an influential 1997 article in *Foreign Affairs*, Fareed Zakaria wrote that rushing the vote in countries lacking an established tradition of good governance, respect for human rights, and the rule of law results in governments likely to abuse authority and, sometimes, promote ethnic divisions. That kind of democracy, he warned, "is not simply inadequate, but dangerous." Elections may have spread across the globe, but for a number of nations a harder challenge remains—to create a government that is truly representative of its people. —*Karen E. Lange*

HOW THE U.S. COMPARES



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GEO QUIZ

PABLO BARTHOLOMEW, GETTY IMAGES

Test Your Political Prowess

1. Where was the birthplace of democracy?
2. Which form of government did Aristotle consider the best in principle?
3. Who was the world's first woman prime minister?
4. After the American Revolution where in the Western Hemisphere did the second successful revolt against a colonial power take place?
5. Where in the U.S. did women first have the right to vote?
6. What country has the world's largest legislative body?
7. Who is the longest serving head of government?
8. Since Franklin Roosevelt's death in 1945, which three U.S. Presidents have served two complete terms?
9. What was Golda Meir's last job before her death in 1978?
10. "From each according to his abilities, to each according to his needs" was said by which political theorist?
11. Who is the woman pictured in the photo above, and who was her father?
12. In what European country is a deposed king the current prime minister?
13. Who is Canada's chief of state?
14. Name the only U.S. President who didn't belong to a political party.
15. Name the only Southeast Asian country not colonized by a Western power during the 19th century.
16. Who was elected South Africa's first president after the end of apartheid?
17. Who heads the world's smallest independent state?
18. What was the first country to allow all women to vote?
19. What continent is governed by a treaty?
20. What is the largest democracy in the world?
21. Name the world's newest independent country.
22. What country has the youngest minimum voting age?
23. In which Caribbean country are the armed forces and police forbidden to vote?
24. When does Mexico celebrate its independence from Spain?
25. Which organization did Lech Walesa lead in fighting for democratic reforms in Poland?

—Katherine Ressler and Kristin Weichman

1. ANCIENT GREECE 2. MONARCHY 3. SIRIMAVO BANDARANAIKE, PRIME MINISTER OF SRI LANKA (1960–1965, 1970–1977, 1994–2000) 4. MATO 5. NEW JERSEY (1776). THE RIGHT WAS WITHDRAWN IN 1807 AND RESTORED IN 1920. 6. CHINA 7. CUBA'S FIDEL CASTRO (1959–PRESENT) 8. DWIGHT EISENHOWER (1953–1961), RONALD REAGAN (1981–1989), BILL CLINTON (1993–2001) 9. PRIME MINISTER OF ISRAEL (1969–1974) 10. KARL MARX 11. INDIRA GANDHI, PRIME MINISTER OF INDIA (1966–1977, 1980–1984) HER FATHER WAS JAWAHARLAL NEHRU, INDIA'S FIRST PRIME MINISTER. 12. BULGARIA. SIMEON SAXE-COBURG-GODHA ASCENDED TO THE THRONE IN 1943 COMMUNISTS ABOLISHED THE MONARCHY IN 1946. HE WAS ELECTED PRIME MINISTER IN 2001. 13. HER MAJESTY ELIZABETH II, QUEEN OF CANADA 14. GEORGE WASHINGTON 15. SIAM, PRESENT-DAY THAILAND 16. NELSON MANDELA 17. POPE JOHN PAUL II 18. NEW ZEALAND (1893) 19. ANTARCTICA 20. INDIA 21. TIMOR-LESTE (EAST TIMOR) 22. IRAN (16) 23. DOMINICAN REPUBLIC 24. SEPTEMBER 16 25. SOLIDARITY

Do It Yourself

DARWIN (SEE PAGE 2)

TUI DE ROY, MINDEN PICTURES

GO THERE

The Galápagos: An Insider's Tips

The best place to witness the phenomena that inspired Charles Darwin is the Galápagos Islands. David Quammen, author of this month's story on evolution, has spent time there and offers this advice:

- **Bring a wet suit.** The Galápagos may be on the Equator, but currents make the water surprisingly cold—and you don't want to miss swimming with sea lions.
- **Don't be in a rush to photograph.** Soak it in. Animals (like boobies, above) lack fear in the absence of predators; there'll be plenty of chances for up close shots.
- **Don't expect a wilderness experience.** "It's more like an art gallery," says Quammen. "The habitat's so fragile, you can't just ramble." For more of his take on the Galápagos, read his article in this month's *National Geographic Adventure*.

TRY IT AT HOME

Darwin Online

In 1835 Darwin ran into some of the Galápagos's strangest residents. "As I was walking along, I met two large tortoises," he recalled in *The Voyage of the Beagle*. "These huge reptiles, surrounded by the black lava, the leafless shrubs, and large cacti, seemed to my fancy like some antediluvian animals." You can now read full-text versions of Darwin's books at *pages.britishlibrary.net/charles.darwin*. His best known work is *The Origin of Species*, but David Quammen also likes some of the less celebrated books (even Darwin's last, on earthworms). Coming soon: Darwin's letters, at *www.lib.cam.ac.uk/Departments/Darwin*.

BETTMANN/CORBIS

PICKS

3 books

Author **David Quammen** has been writing about evolution for 25 years. He suggests these books on Darwin and his legacy:

- ***What Evolution Is*, by Ernst Mayr** The most accessible book on the subject by one of the most important evolutionary biologists and science historians of the 20th century. A clear and graceful writer, Mayr celebrated his 100th birthday in July.
- ***Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory*, by Niles Eldredge** A paleontologist reflects on a provocative modification of Darwinian thought: punctuated equilibria, a theory he and the late Stephen Jay Gould conceived about the pace of evolution.
- ***The Voyage of the Beagle*, by Charles Darwin** A great travel book that just happens to be written by one of the great scientists of the 19th century, Darwin's account of his voyage on the *Beagle* takes you from the Andes to Tahiti and, of course, to the Galápagos.

WEBSITE EXCLUSIVE

Link to Darwin sites selected by our Research Department at **nationalgeographic.com/magazine/0411**.

My Seven

The Geography of U.S. Elections

James E. Campbell *Political Scientist, University at Buffalo, SUNY*

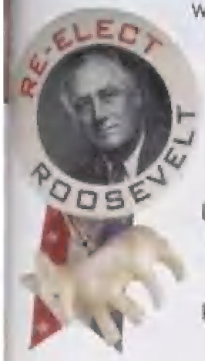
Who'll win the White House? There's no better person to ask than James Campbell. He came closer to predicting the popular vote in 2000 than any other political science prognosticator. His formulas rely heavily on the economy and polls, but we asked him for something more up our alley—geographic and demographic indicators.

REBECCA HALE, NGS STAFF (TOP); BETTMANN/CORBIS (ABOVE); HARTFORD UNIVERSITY

1 Bellwethers Four states—Missouri, Nevada, Ohio, and Tennessee—have voted for the winner in 13 of the last 14 elections. Since 1948 every candidate who carried at least three of them won.

2 Magic numbers Republicans do better in less populous states, so they need to carry more of them to win an electoral majority. No Republican since 1904 has been elected without winning at least 30 states. The Democrats' magic number: 23.

3 Gender gap Since 1980 the gender gap has been a factor in elections: Democrats, who tend to run stronger among females, have needed at least 55 percent of the women's vote to win the popular vote.



4 Bigger home states From 1900 on, 18 of the 26 presidential elections were between candidates whose home states differed by 10 or more electoral votes. The candidate from the larger state won two-thirds of the time. (Texas has 34 electoral votes, Massachusetts 12.)

5 Twentysomethings Since Eisenhower's second election in 1956, candidates who carried the under-30 vote won in all but two presidential contests.

6 Must-haves Six states have been in the column of every winning Democrat since 1948, while 18 states are consistently carried by winning Republicans. In 2000 Democrats lost three of their must-haves: Arkansas, Missouri, and West Virginia. Closely decided must-have Republican wins: Florida, Tennessee, New Hampshire, and Ohio.

7 It starts at home In the 20th century only one candidate was elected without winning his home state: Woodrow Wilson lost New Jersey in 1916.

WEBSITE EXCLUSIVE
Who will win? Get Jim Campbell's prediction on the outcome of the 2004 presidential election at **nationalgeographic.com/magazine/0411.**

Who Knew?

ENGINEERING

Who's Driving?

Things still go better with humans at the helm

Thirteen vehicles lined up last March to race across the Mojave Desert, seeking a cool million in prize money. To win, they had to finish the 142-mile course in less than 10 hours. Teams and spectators knew there might be no winner at all, because these vehicles were missing a key element: drivers.

DARPA, the Defense Advanced Research Projects Agency, sponsored the race as part of a push to develop robotic vehicles for future battlefields. But the Grand Challenge, as it was called, proved a spectacular demonstration of just how difficult it is to get a car or buggy to speed across an unfamiliar landscape without human guidance. One had its brake lock up in the starting area. Another began by slamming into a wall. Another got spooked by bushes near the road after 1.2 miles.

One flipped. One took off in entirely the wrong direction and had to be disabled by remote control. One went a little more than a mile and plunged through a fence; another managed to go for six miles but got stuck on a rock. The "winner," if you will, reached 7.4 miles before it ran into a berm, and the front wheels caught on fire.

"You get a lot of respect for natural biological systems," says Reinhold Behringer, who helped design two of the car-size vehicles for a company called SciAutonics. "Even ants do all these functions effortlessly. It's very hard for us to imitate that and put it into our machines."

The autonomous vehicles, despite being loaded with lasers, radar, stereoscopic cameras, gyroscopes, advanced computers, and GPS guidance, had trouble figuring out fast enough the significance of obstacles that a two-year-old human recognizes immediately. Sure, that toddler may not think to wipe spaghetti sauce off her face, but she already knows that when there's a cookie in the kitchen she has to climb up to the cabinet, and that when she gets to the cookie it will taste good. She is more advanced, even in diapers, than any machine humans have devised.

For the fantastically successful Mars rovers, *Spirit* and *Opportunity*, fast movement and quick thinking were never priorities. Top rover speed, pedal to the metal: a tenth of a mile an hour. The Grand Challenge vehicles, on the other hand, were supposed to go 15 miles an hour. Unlike the Grand Challenge vehicles, the Mars rovers were designed to wait for human input in uncertain situations. "The rover has the intelligence of a bug," says mission manager Mark Adler. "It can go around an obstacle. It can detect hazards. But we've got a long way to go from a bug to what a two-year-old can do." (Sometimes, says Adler, technicians would watch a rover come to a standstill for no apparent reason.)

There'll be more autonomous vehicle races in the desert. Someday a buggy will speed along for 142 miles on its own. Meanwhile, we'll keep humans—at least remotely—in the driver's seat.

—Joel Achenbach
WASHINGTON POST STAFF WRITER

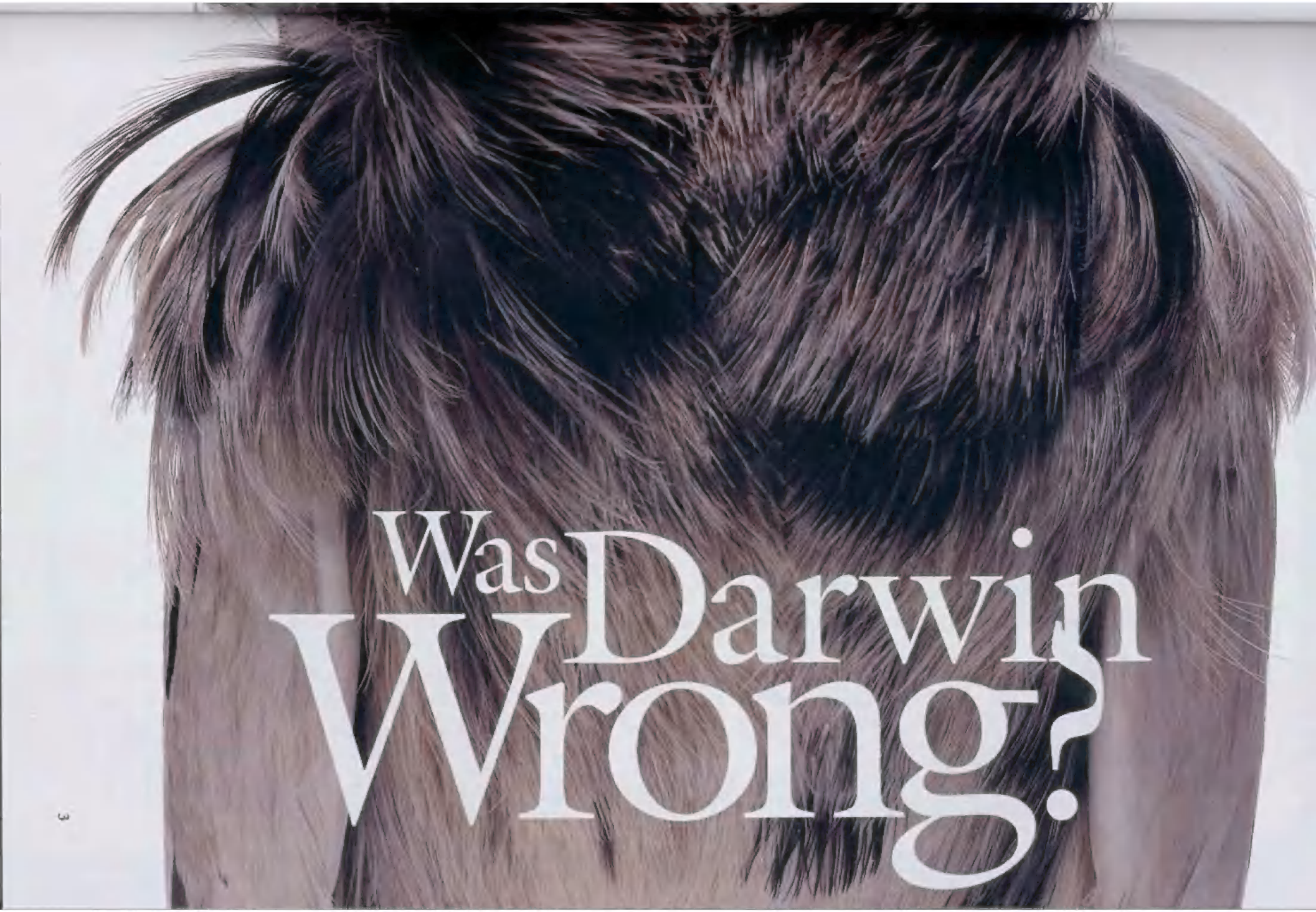
PHOTO ILLUSTRATION BY CARY WOLINSKY AND BARBARA WOLINSKY

Underwater Advantage

Autonomous underwater vehicles (AUVs), like their terrestrial counterparts, are designed to perform without help from the humans who make and program them. Unlike land-based vehicles, AUVs have achieved considerable independence. They explore for pipeline and cable routes and investigate ocean ridges, vents, and floor—all without real-time remote control. How do they do it? Most AUVs operate in the open ocean and can rise above obstacles. AUV computer brains can spend more time collecting data and less time trying to recognize and avoid bushes, potholes, and the occasional fence.

—Heidi Schultz

WEBSITE EXCLUSIVE For more on autonomous vehicles, and for links to Joel Achenbach's work: Resources at nationalgeographic.com/magazine/0411.


Was Darwin Wrong?

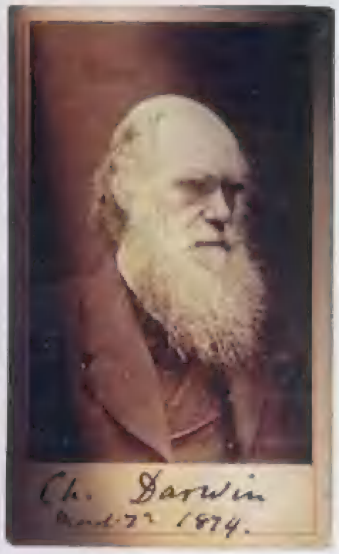
NO.

The evidence for Evolution is overwhelming.

By DAVID QUAMMEN
Photographs by ROBERT CLARK

Charles Darwin's grand theory, evolution by natural selection, links diverse biological facts into a coherent whole. Domestic breeding of fancy pigeons like the Jacobin (preceding pages) was his analogy for selection in the wild. The naked mole rat (opposite) shows that mammals can evolve, like social insects, to include specialized workers and queens.

Evolution by natural selection, the central concept of the life's work of Charles Darwin, is a theory. It's a theory about the origin of adaptation, complexity, and diversity among Earth's living creatures. If you are skeptical by nature, unfamiliar with the terminology of science, and unaware of the overwhelming evidence, you might even be tempted to say that it's "just" a theory. In the same sense, relativity as described by Albert Einstein is "just" a theory. The notion that Earth orbits around the sun rather than vice versa, offered by Copernicus in 1543, is a theory. Continental drift is a theory. The existence, structure, and dynamics of atoms? Atomic theory. Even electricity is a theoretical construct, involving electrons, which are tiny units of charged mass that no one has ever seen. Each of these theories is an explanation that has been confirmed to such a degree, by observation and



Darwin was a shy, conservative man, who asked penetrating questions. The giraffe (opposite) intrigued him less for the length of its neck than for the shape of its tail, which looked to him like a "fly-flapper." Fly-swatting, he noted, could help an animal survive.

experiment, that knowledgeable experts accept it as fact. That's what scientists mean when they talk about a theory: not a dreamy and unreliable speculation, but an explanatory statement that fits the evidence. They embrace such an explanation confidently but provisionally—taking it as their best available view of reality, at least until some severely conflicting data or some better explanation might come along.

The rest of us generally agree. We plug our televisions into little wall sockets, measure a year by the length of Earth's orbit, and in many other ways live our lives based on the trusted reality of those theories.

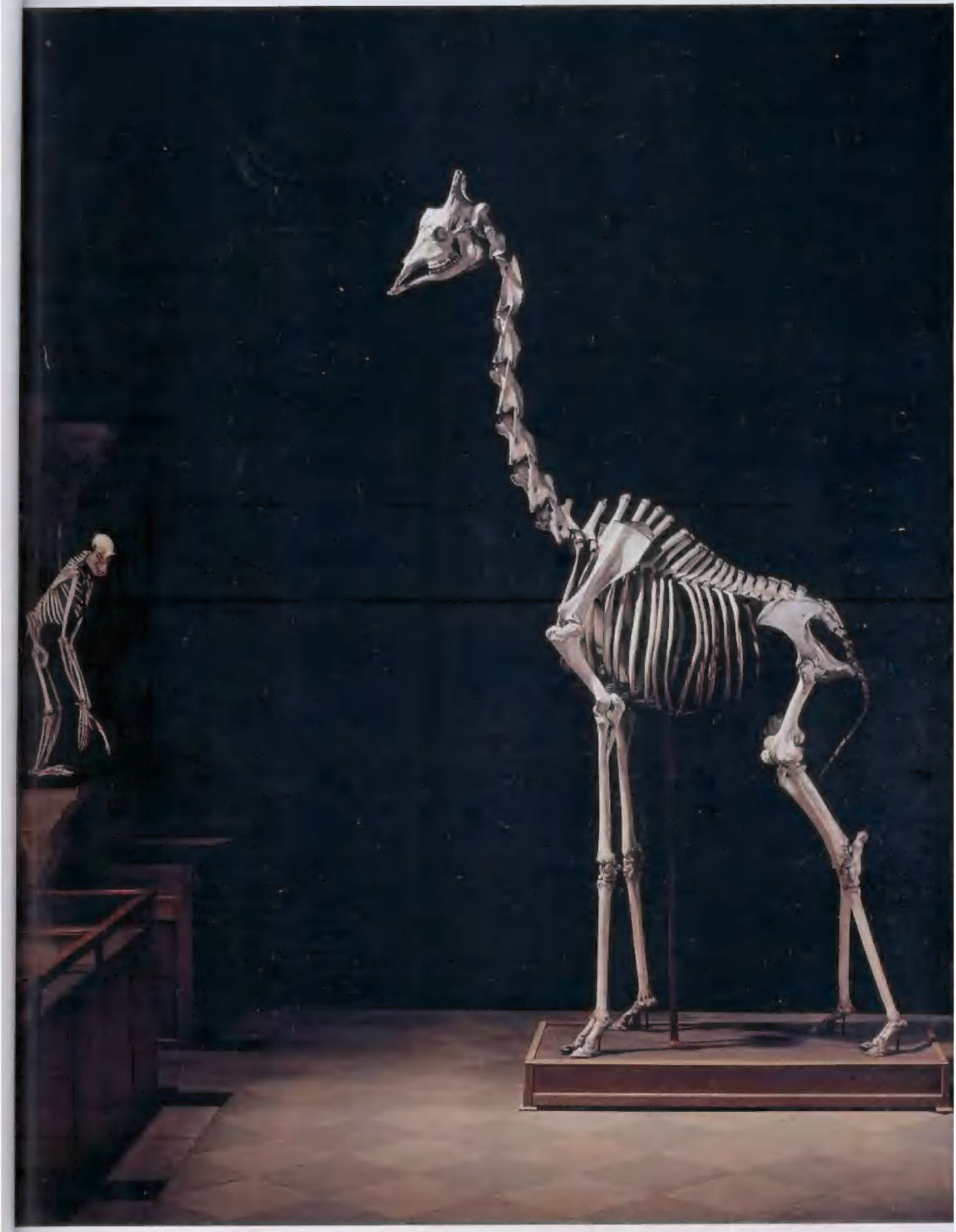
Evolutionary theory, though, is a bit different. It's such a dangerously wonderful and far-reaching view of life that some people find it unacceptable, despite the vast body of supporting evidence. As applied to our own species, *Homo sapiens*, it can seem more threatening still. Many fundamentalist Christians and ultra-orthodox Jews take alarm at the thought that human descent from earlier primates contradicts a strict reading of the Book of Genesis. Their discomfort is paralleled by Islamic creationists such as Harun Yahya, author of a recent volume titled *The Evolution Deceit*, who points to the six-day creation story in the Koran as literal truth and calls the theory of evolution "nothing but a deception imposed on us by the dominators of the world system." The late Srila Prabhupada, of the Hare Krishna movement, explained that God created "the 8,400,000 species of life from the very beginning," in order to establish multiple tiers of reincarnation for rising souls. Although souls ascend, the species themselves don't change, he insisted, dismissing "Darwin's nonsensical theory."

Other people too, not just scriptural literalists, remain unpersuaded about evolution. According to a Gallup poll drawn from more than a thousand telephone interviews conducted in February 2001, no less than 45 percent of responding U.S. adults agreed that "God created human beings pretty much in their present form at one time within the last 10,000 years or so." Evolution, by their lights, played no role in shaping us.

Only 37 percent of the polled Americans were satisfied with allowing room for both God and Darwin—that is, divine initiative to get things started, evolution as the creative means. (This view, according to more than one papal pronouncement, is compatible with Roman Catholic dogma.) Still fewer Americans, only 12 percent, believed that humans evolved from other life-forms without any involvement of a god.

The most startling thing about these poll numbers is not that so many Americans reject evolution, but that the statistical breakdown hasn't changed much in two decades. Gallup interviewers posed exactly the same choices in 1982, 1993, 1997, and 1999. The creationist conviction—that God alone, and not evolution, produced humans—has never drawn less than 44 percent. In other words, nearly half the American populace prefers to believe that Charles Darwin was wrong where it mattered most.

Why are there so many antievolutionists? Scriptural literalism can only be part of the answer. The American public certainly includes a large segment of scriptural literalists—but not *that* large, not 44 percent. Creationist proselytizers and political activists, working hard to interfere with the teaching of evolutionary biology in public schools, are another part. Honest confusion and ignorance, among millions of adult Americans, must be still another. Many people have never taken a biology course that dealt with evolution nor read a book in which the theory was lucidly explained. Sure, we've all



PHOTOGRAPHED AT OXFORD UNIVERSITY MUSEUM OF NATURAL HISTORY (SKELETONS) AND AT WILLIAM L. CLEMENTS LIBRARY, UNIVERSITY OF MICHIGAN, ANN ARBOR (PORTRAIT)

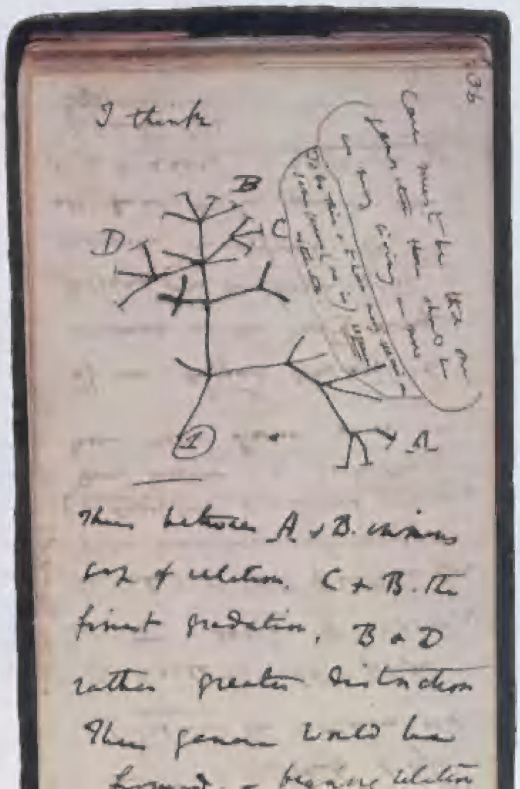
Evolution is a beautiful concept, MORE CRUCIAL to medical science, and to our

heard of Charles Darwin, and of a vague, somber notion about struggle and survival that sometimes goes by the catchall label "Darwinism." But the main sources of information from which most Americans have drawn their awareness of this subject, it seems, are haphazard ones at best: cultural osmosis, newspaper and magazine references, half-baked nature documentaries on the tube, and hearsay.

Evolution is both a beautiful concept and an important one, more crucial nowadays to human welfare, to medical science, and to our understanding of the world than ever before. It's also deeply persuasive—a theory you can take to the bank. The essential points are slightly more complicated than most people assume, but not so complicated that they can't be comprehended by any attentive person. Furthermore, the supporting evidence is abundant, various, ever increasing, solidly interconnected, and easily available in museums, popular books, textbooks, and a mountainous accumulation of peer-reviewed scientific studies. No one needs to, and no one should, accept evolution merely as a matter of faith.

Two big ideas, not just one, are at issue: the evolution of all species, as a historical phenomenon, and natural selection, as the main mechanism causing that phenomenon. The first is a question of what happened. The second is a question of how. The idea that all species are descended from common ancestors had been suggested by other thinkers, including Jean-Baptiste Lamarck, long before Darwin published *The Origin of Species* in 1859. What made Darwin's book so remarkable when it appeared, and so influential in the long run, was that it offered a rational explanation of how evolution must occur. The same insight came independently to Alfred Russel Wallace, a young naturalist doing fieldwork in the Malay Archipelago during the late 1850s. In historical annals, if not in the popular awareness, Wallace and Darwin share the kudos for having discovered natural selection.

The gist of the concept is that small, random, heritable differences among individuals result in different chances of survival and reproduction—success for some, death without offspring for others—and that this natural culling leads to significant changes in shape, size, strength, armament, color, biochemistry, and behavior among the descendants. Excess population growth drives the competitive struggle. Because less successful competitors produce fewer surviving offspring, the useless or negative variations tend to disappear, whereas the useful variations tend to be perpetuated and gradually magnified throughout a population.



In an 1837 notebook Darwin sketched his favorite metaphor: a tree of life (left), its twigs as species. Then, believing no one should speculate about species "who has not minutely described many," he spent eight years classifying barnacles (above). By 1854 he was known as a barnacle expert—though not yet an evolutionist.

CAMBRIDGE UNIVERSITY LIBRARY (LEFT); ENGLISH HERITAGE PHOTOGRAPHIC LIBRARY, DOWN HOUSE, KENT

AI NOWADAYS to human welfare,
ou understanding of the world than ever before.

So much for one part of the evolutionary process, known as anagenesis, during which a single species is transformed. But there's also a second part, known as speciation. Genetic changes sometimes accumulate within an isolated segment of a species, but not throughout the whole, as that isolated population adapts to its local conditions. Gradually it goes its own way, seizing a new ecological niche. At a certain point it becomes irreversibly distinct—that is, so different that its members can't interbreed with the rest. Two species now exist where formerly there was one. Darwin called that splitting-and-specializing phenomenon the "principle of divergence." It was an important part of his theory, explaining the overall diversity of life as well as the adaptation of individual species.

This thrilling and radical assemblage of concepts came from an unlikely source. Charles Darwin was shy and meticulous, a wealthy landowner with close friends among the Anglican clergy. He had a gentle, unassuming manner, a strong need for privacy, and an extraordinary commitment to intellectual honesty. As an undergraduate at Cambridge, he had studied halfheartedly toward becoming a clergyman himself, before he discovered his real vocation as a scientist. Later, having established a good but conventional reputation in natural history, he spent 22 years secretly gathering evidence and pondering arguments—both for and against his theory—because he didn't want to flame out in a burst of unpersuasive notoriety. He may have delayed, too, because of his anxiety about announcing a theory that seemed to challenge conventional religious beliefs—in particular, the Christian beliefs of his wife, Emma. Darwin himself quietly renounced Christianity during his middle age, and later described himself as an agnostic. He continued to believe in a distant, impersonal deity of some sort, a greater entity that had set the universe and its laws into motion, but not in a personal God who had chosen humanity as a specially favored species. Darwin avoided flaunting his lack of religious faith, at least partly in deference to Emma. And she prayed for his soul.

In 1859 he finally delivered his revolutionary book. Although it was hefty and substantive at 490 pages, he considered *The Origin of Species* just a quick-and-dirty "abstract" of the huge volume he had been working on until interrupted by an alarming event. (In fact, he'd wanted to title it *An Abstract of an Essay on the Origin of Species and Varieties Through Natural Selection*, but his publisher found that insufficiently catchy.) The alarming event was his receiving a letter and an enclosed manuscript from Alfred Wallace, whom he knew only as a distant pen pal. Wallace's manuscript sketched out the same great idea—evolution by natural selection—that Darwin considered his own. Wallace had scribbled this paper and (unaware of Darwin's own evolutionary thinking, which so far had been kept private) mailed it to him from the Malay Archipelago, along with a request for reaction and help. Darwin was horrified. After two decades of painstaking effort, now he'd be scooped. Or maybe not quite. He forwarded Wallace's paper toward publication, though managing also to assert his own prior claim by releasing two excerpts from his unpublished work. Then he dashed off *The Origin*, his "abstract" on the subject. Unlike Wallace, who was younger and less meticulous, Darwin recognized the importance of providing an edifice of supporting evidence and logic.

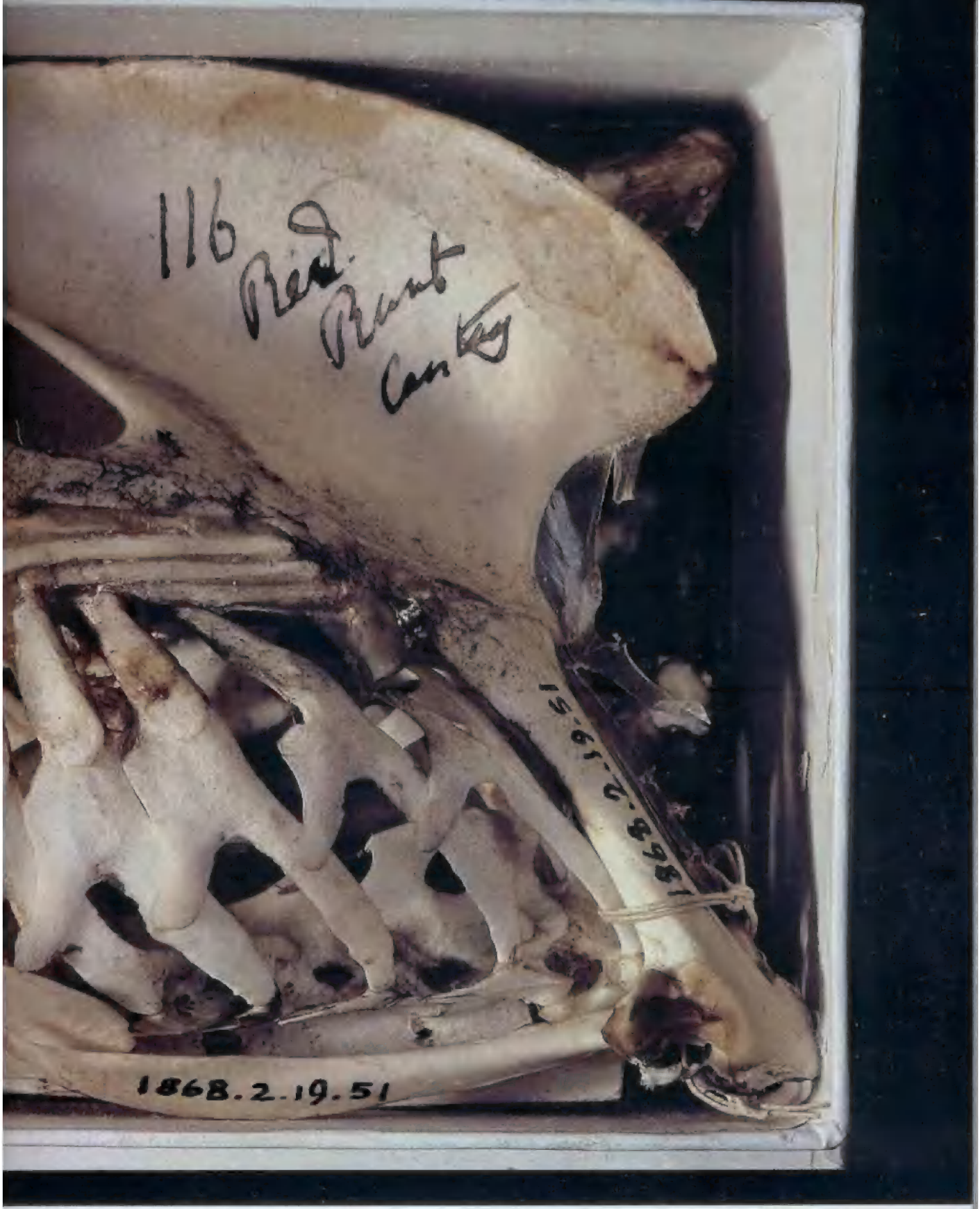
The evidence, as he presented it, mostly fell within four categories: biogeography, paleontology, embryology, and morphology. Biogeography is the study of the geographical distribution of living creatures—that is, which species inhabit which parts of the planet and why. Paleontology investigates extinct life-forms, as revealed in the fossil record. Embryology examines the revealing stages of development (echoing earlier stages of evolutionary history) that embryos pass through before birth or hatching; at a stretch, embryology also concerns the immature forms of animals that metamorphose, such as the larvae of insects. Morphology is the science of anatomical shape and design. Darwin devoted sizable sections of *The Origin of Species* to these categories.

Biogeography, for instance, offered a great

Uncovering Data

A keen observer and theorist, Darwin was also a veteran dissector and hands-on experimentalist. To explore the mysteries of variation, he set up an aviary behind his house and became a breeder of fancy pigeons, at one point keeping nearly 90 birds. He compared the skeletal anatomy of different breeds, looking for

PHOTOGRAPHED AT NATURAL HISTORY MUSEUM, TRING, UNITED KINGDOM



similarities that might show their descent from a single wild species, the rock dove. Boiling the flesh off carcasses with help from his butler, he found that "when I took the body out of the water, the smell was so dreadful that it made me wretch awfully." So he outsourced that work. This specimen was a red runt, as recorded in Darwin's handwriting.

WHY DO MALE MAMMALS (including hum
the rudiments of tiny legs? Why do certa

pageant of peculiar facts and patterns. Anyone who considers the biogeographical data, Darwin wrote, must be struck by the mysterious clustering pattern among what he called "closely allied" species—that is, similar creatures sharing roughly the same body plan. Such closely allied species tend to be found on the same continent (several species of zebras in Africa) or within the same group of oceanic islands (dozens of species of honeycreepers in Hawaii, thirteen species of Galápagos finch), despite their species-by-species preferences for different habitats, food sources, or conditions of climate. Adjacent areas of South America, Darwin noted, are occupied by two similar species of large, flightless birds (the rheas, *Rhea americana* and *Pterocnemia pennata*), not by ostriches as in Africa or emus as in Australia. South America also has agoutis and viscachas (small rodents) in terrestrial habitats, plus coypus and capybaras in the wetlands, not—as Darwin wrote—hares and rabbits in terrestrial habitats or beavers and muskrats in the wetlands. During his own youthful visit to the Galápagos, aboard the survey ship *Beagle*, Darwin himself had discovered three very similar forms of mockingbird, each on a different island.

Why should "closely allied" species inhabit neighboring patches of habitat? And why should similar habitat on different continents be occupied by species that aren't so closely allied? "We see in these facts some deep organic bond, prevailing throughout space and time," Darwin wrote. "This bond, on my theory, is simply inheritance." Similar species occur nearby in space because they have descended from common ancestors.

Paleontology reveals a similar clustering pattern in the dimension of time. The vertical column of geologic strata, laid down by sedimentary processes over the eons, lightly peppered with fossils, represents a tangible record showing which species lived when. Less ancient layers of rock lie atop more ancient ones (except where geologic forces have tipped or shuffled them), and likewise with the animal and plant fossils that the strata contain. What Darwin noticed about this record is that closely allied species tend to be found adjacent to one another in successive strata. One species endures for millions of years and then makes its last appearance in, say, the middle Eocene epoch; just above, a similar but not identical species replaces it. In North America, for example, a vaguely horselike creature known as *Hyracotherium* was succeeded by *Orohippus*, then *Epihippus*, then *Mesohippus*, which in turn were succeeded by a variety of horsey American critters. Some of them even galloped across the Bering land bridge into Asia, then onward to Europe and Africa. By five million years ago they had nearly all disappeared, leaving behind *Dinohippus*, which was succeeded by *Equus*, the modern genus of horse. Not all these fossil links had been unearthed in Darwin's day, but he captured the essence of the matter anyway. Again, were such sequences just coincidental? No, Darwin argued. Closely allied species succeed one another in time, as well as living nearby in space, because

Mustering facts from many diverse realms, Darwin saw the implications of albinism (above) as an inherited trait and noted the wings of a flying fish. Although the fish's wings are rudimentary compared to a bird's, he realized that they derive from the same evolutionary process: They enable the fish to soar to escape predators.

males) have nipples? Why do some snakes carry species of flightless beetles have wings that never open?

they're related through evolutionary descent.

Embryology too involved patterns that couldn't be explained by coincidence. Why does the embryo of a mammal pass through stages resembling stages of the embryo of a reptile? Why is one of the larval forms of a barnacle, before metamorphosis, so similar to the larval form of a shrimp? Why do the larvae of moths, flies, and beetles resemble one another more than any of them resemble their respective adults? Because, Darwin wrote, "the embryo is the animal in its less modified state" and that state "reveals the structure of its progenitor."

Morphology, his fourth category of evidence, was the "very soul" of natural history, according to Darwin. Even today it's on display in the layout and organization of any zoo. Here are the monkeys, there are the big cats, and in that building are the alligators and crocodiles. Birds in the aviary, fish in the aquarium. Living creatures can be easily sorted into a hierarchy of categories—not just species but genera, families, orders, whole kingdoms—based on which anatomical characters they share and which they don't.

All vertebrate animals have backbones. Among vertebrates, birds have feathers, whereas reptiles have scales. Mammals have fur and mammary glands, not feathers or scales. Among mammals, some have pouches in which they nurse their tiny young. Among these species, the marsupials, some have huge rear legs and strong tails by which they go hopping across miles of arid outback; we call them kangaroos. Bring in modern microscopic and molecular evidence, and you can trace the similarities still further back. All plants and fungi, as well as animals, have nuclei within their cells. All living organisms contain DNA and RNA (except some viruses with RNA only), two related forms of information-coding molecules.

Such a pattern of tiered resemblances—groups of similar species nested within broader groupings, and all descending from a single source—isn't naturally present among other collections of items. You won't find anything equivalent if you try to categorize rocks, or musical instruments, or jewelry. Why not? Because rock types and styles of jewelry don't reflect unbroken descent from common ancestors. Biological diversity does. The number of shared characteristics between any one species and another indicates how recently those two species have diverged from a shared lineage.

That insight gave new meaning to the task of taxonomic classification, which had been founded in its modern form back in 1735 by the Swedish naturalist Carolus Linnaeus. Linnaeus showed how species could be systematically classified, according to their shared similarities, but he worked from creationist assumptions that offered no material explanation for the nested pattern he found. In the early and middle 19th century, morphologists such as Georges Cuvier and Étienne Geoffroy Saint-Hilaire in France and Richard Owen in England improved classification with their meticulous studies of internal as well as external anatomies, and tried to make sense of what the ultimate source of these patterned similarities could be. Not even Owen, a contemporary and onetime friend of Darwin's (later in life they had a bitter falling out), took the full step to an evolutionary vision before *The Origin of Species* was published. Owen made a major contribution, though, by advancing the concept of homologues—that is, superficially different but fundamentally similar versions of a single organ or trait, shared by dissimilar species.

For instance, the five-digit skeletal structure of the vertebrate hand appears not just in humans and apes and raccoons and bears but also, variously modified, in cats and bats and porpoises and lizards and turtles. The paired bones of our lower leg, the tibia and the fibula, are also represented by homologous bones in other mammals and in reptiles, and even in the long-extinct bird-reptile *Archaeopteryx*. What's the reason behind such varied recurrence of a few basic designs? Darwin, with a nod to Owen's "most interesting work," supplied the answer: common descent, as shaped by natural selection, modifying *(Continued on page 20)*

COEVOLUTION

Seeing Like Darwin

Orchids, wondrously adapted for controlling their pollination by insects, intrigued Darwin. The parts of their strangely modified flowers, he saw, correspond to the flower parts on simpler plants, suggesting evolutionary change. One species that caught his eye was the Madagascar orchid *Angraecum sesquipedale* (inset), with its 11-inch-long nectar receptacle. He predicted that somewhere in Madagascar, a place he had never visited, must live a moth with a proboscis 11 inches long, adapted to harvest the orchid's nectar. Forty years later two entomologists revealed the Madagascan sphinx moth *Xanthopan morganii praedicta,* confirming Darwin's forecast. Such mutual adaptation—the moth to the flower, the flower to the moth—is called coevolution.

PHOTOGRAPHED AT NEW YORK BOTANICAL GARDEN (ORCHID) AND AT NATURAL HISTORY MUSEUM, LONDON (MOTH)

Domestic Selection

The bulldog (opposite), **shaped by many generations of dog breeders for bullbaiting and, later, for homely charm, differs much from its wolfish progenitors. If domestic breeding could yield such change, Darwin realized, natural selection** over many millions of years could do more. He argued that wild species diverge from common ancestors just as domestic varieties do. Using his own backyard aviary, as well as information from other breeders, he analyzed differences among fancy pigeons such as (above, clockwise from left) the English pouter, the scandaroon, and the nun. He also studied cats, horses, pigs, rabbits, ducks, and other livestock. He examined and measured specimens, alive and dead. To a friend he wrote, "I have puppies of Bull-dogs & Greyhound in salt."

Natural Selection

Darwin took a crucial idea from the population theorist Thomas Malthus: More individuals are born than can survive and reproduce, given the limitations of food and space. Malthus wrote about human society, but Darwin applied this to all species. The overabundance of offspring, such as salmon sac fry (opposite), creates competition, in which better adapted individuals succeed. Failure means death without offspring—or, for the *Waptia*, a peculiar animal known only from Cambrian shale (above left), extinction without descendant species. Insectivorous plants such as the Venus flytrap (above right) occupy nutrient-poor soils, where competition is less severe, and survive by supplementing their diet with captured insects.

PHOTOGRAPHED AT NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION (FOSSIL); AT ROYAL BOTANIC GARDENS, KEW (FLYTRAP); AND AT ATLANTIC SALMON FEDERATION/AQUATIC CENTRE FOR RESEARCH AND EDUCATION, NEWFOUNDLAND (SAC FRY)

Evolutionary theory is such a dangerous of life that some people find it unacceptable, despite t

(Continued from page 13) the inherited basics for different circumstances.

Vestigial characteristics are still another form of morphological evidence, illuminating to contemplate because they show that the living world is full of small, tolerable imperfections. Why do male mammals (including human males) have nipples? Why do some snakes (notably boa constrictors) carry the rudiments of a pelvis and tiny legs buried inside their sleek profiles? Why do certain species of flightless beetle have wings, sealed beneath wing covers that never open? Darwin raised all these questions, and answered them, in *The Origin of Species.* Vestigial structures stand as remnants of the evolutionary history of a lineage.

Today the same four branches of biological science from which Darwin drew—biogeography, paleontology, embryology, morphology—embrace an ever growing body of supporting data. In addition to those categories we now have others: population genetics, biochemistry, molecular biology, and, most recently, the whiz-bang field of machine-driven genetic sequencing known as genomics. These new forms of knowledge overlap one another seamlessly and intersect with the older forms, strengthening the whole edifice, contributing further to the certainty that Darwin was right.

He was right about evolution, that is. He wasn't right about *everything.* Being a restless explainer, Darwin floated a number of theoretical notions during his long working life, some of which were mistaken and illusory. He was wrong about what causes variation within a species. He was wrong about a famous geologic mystery, the parallel shelves along a Scottish valley called Glen Roy. Most notably, his theory of inheritance—which he labeled pangenesis and cherished despite its poor reception among his biologist colleagues—turned out to be dead wrong. Fortunately for Darwin, the correctness of his most famous good idea stood independent of that particular bad idea. Evolution by natural selection represented Darwin at his best—which is to say, scientific observation and careful thinking at its best.

Douglas Futuyma is a highly respected evolutionary biologist, author of textbooks as well as influential research papers. His office, at the University of Michigan, is a long narrow room in the natural sciences building, well stocked with journals and books, including volumes about the conflict between creationism and evolution. I arrived carrying a well-thumbed copy of his own book on that subject, *Science on Trial: The Case for Evolution.* Killing time in the corridor before our appointment, I noticed a blue flyer on a departmental bulletin board, seeming oddly placed there amid the announcements of career opportunities for graduate students. "CREATION VS. EVOLUTION," it said. "A series of messages challenging popular thought with Biblical truth and scientific evidences." A traveling lecturer from something called the Origins Research Association would deliver these messages at a local Baptist church. Beside the lecturer's photo was a drawing of a dinosaur. "Free pizza following the evening service," said a small line at the bottom. Dinosaurs, biblical truth, and pizza: something for everybody.

In response to my questions about evidence, Dr. Futuyma moved quickly through the traditional categories—paleontology, biogeography—and talked mostly about modern genetics. He pulled out his heavily marked copy of the journal *Nature* for February 15, 2001, a historic issue, fat with articles reporting and analyzing the results of the Human Genome Project. Beside it he slapped down a more recent issue of *Nature,* this one devoted to the sequenced genome of the house mouse, *Mus musculus.* The headline of the lead editorial announced: "HUMAN BIOLOGY BY PROXY." The mouse genome effort, according to *Nature*'s editors, had revealed "about 30,000 genes, with 99% having direct counterparts in humans."

The resemblance between our 30,000 human genes and those 30,000 mousy counterparts, Futuyma explained, represents another form of homology, like the resemblance between a five-fingered hand and a five-toed paw. Such genetic homology is what gives meaning to

WONDERFUL AND FAR-REACHING view
vast body of supporting evidence.

biomedical research using mice and other animals, including chimpanzees, which (to their sad misfortune) are our closest living relatives.

No aspect of biomedical research seems more urgent today than the study of microbial diseases. And the dynamics of those microbes within human bodies, within human populations, can only be understood in terms of evolution.

Nightmarish illnesses caused by microbes include both the infectious sort (AIDS, Ebola, SARS) that spread directly from person to person and the sort (malaria, West Nile fever) delivered to us by biting insects or other intermediaries. The capacity for quick change among disease-causing microbes is what makes them so dangerous to large numbers of people and so difficult and expensive to treat. They leap from wildlife or domestic animals into humans, adapting to new circumstances as they go. Their inherent variability allows them to find new ways of evading and defeating human immune systems. By natural selection they acquire resistance to drugs that should kill them. They evolve. There's no better or more immediate evidence supporting the Darwinian theory than this process of forced transformation among our inimical germs.

Take the common bacterium *Staphylococcus aureus,* which lurks in hospitals and causes serious infections, especially among surgery patients. Penicillin, becoming available in 1943, proved almost miraculously effective in fighting staphylococcus infections. Its deployment marked a new phase in the old war between humans and disease microbes, a phase in which humans invent new killer drugs and microbes find new ways to be unkillable. The supreme potency of penicillin didn't last long. The first resistant strains of *Staphylococcus aureus* were reported in 1947. A newer staph-killing drug, methicillin, came into use during the 1960s, but methicillin-resistant strains appeared soon, and by the 1980s those strains were widespread. Vancomycin became the next great weapon against staph, and the first vancomycin-resistant strain emerged in 2002. These antibiotic-resistant strains represent an evolutionary series, not much different in principle from the fossil series tracing horse evolution from *Hyracotherium* to *Equus.* They make evolution a very practical problem by adding expense, as well as misery and danger, to the challenge of coping with staph.

The biologist Stephen Palumbi has calculated the cost of treating penicillin-resistant and methicillin-resistant staph infections, just in the United States, at 30 billion dollars a year. "Antibiotics exert a powerful evolutionary force," he wrote last year, "driving infectious bacteria to evolve powerful defenses against all but the most recently invented drugs." As reflected in their DNA, which uses the same genetic code found in humans and horses and hagfish and honeysuckle, bacteria are part of the continuum of life, all shaped and diversified by evolutionary forces.

Even viruses belong to that continuum. Some viruses evolve quickly, some slowly. Among the fastest is HIV, because *(Continued on page 30)*

Similarities of anatomy imply common origins. The orangutan (right) has long arms, but its paired forearm bones resemble the radius and ulna in a human. The orangutan hand (below left) is so similar to ours (below right) that it might fit in a first-baseman's mitt.

PHOTOGRAPHED AT NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION (HUMAN HAND) AND AT OXFORD UNIVERSITY MUSEUM OF NATURAL HISTORY

Anatomical Clues

In the wilds of Argentina, Darwin saw two species of large flightless bird, one of them (above right) called Darwin's rhea in his honor. Why did South America harbor these similar forms, rather than ostriches, as in Africa, or maybe moas (above left), as in New Zealand? Such clustered patterns of what he called "closely allied" species suggest local evolution from common ancestors. Two primitive worker ants, preserved in amber from the Cretaceous period (opposite), offer another sort of evidence: anatomical clues such as wasplike antennae and a broad waist, revealing their transitional status between ancestral wasps and ants. Biogeography (which animals live where) and the fossil record (in amber or stone) are as important for modern biologists as they were for Darwin.

PHOTOGRAPHED AT OXFORD UNIVERSITY MUSEUM OF NATURAL HISTORY (MOA); AT LUESTHER T. MERTZ LIBRARY, NEW YORK BOTANICAL GARDEN (DARWIN'S RHEA); AND AT AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK (AMBER)

MISSING LINKS FOUND

Fossil Evidence

At a dig in Egypt a team of paleontologists, among them the University of Michigan's Philip Gingerich, found the nearly complete skeleton of a whalelike creature now called *Dorudon* (replica, opposite). **Dating back 40 million years, it had a detached pelvis** near the end of its tail and useless little legs. Like the human hand, an early whale's front foot (above right) retains a five-fingered bone structure; a vestigial rear foot (above left) has lost several toe bones, but its very existence testifies to the whale's descent from a four-legged ancestor. Illuminating but spotty, the fossil record is like a film of evolution from which 999 of every 1,000 frames have been lost on the cutting-room floor. Still, Gingerich and others have found dozens of intermediate forms—missing links that are no longer missing.

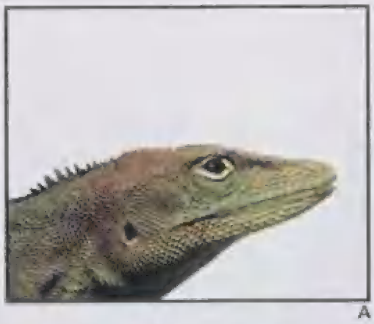
PHOTOGRAPHED AT EXHIBIT MUSEUM OF NATURAL HISTORY, UNIVERSITY OF MICHIGAN, ANN ARBOR *(DORUDON)* AND AT UNIVERSITY OF MICHIGAN

Island Biogeography

In the Galápagos Islands in 1835, Darwin collected some small brownish birds, hardly notable except for the various sizes and shapes of their beaks. Back in England the ornithologist John Gould declared them to be "ground finches," more than a dozen new species, unknown to science. There was a similar

PHOTOGRAPHED AT NATURAL HISTORY MUSEUM, TRING

pattern of diversification, Darwin had noticed, among Galápagos tortoises and among mockingbirds. Why should remote islands contain such diversity? His answer was that isolation—plus time, plus adaptation to local conditions—leads to the origin of species. It seemed more logical than assuming they had been created and placed in the Galápagos individually.


A


B


C


D


E


F

Convergent Evolution

Its short legs suited for clinging to narrow branches, the Jamaican twig anole (B) strikingly resembles the Puerto Rican twig anole (C) and the Hispaniolan twig anole (D). Yet DNA-based studies by Jonathan Losos of Washington University in St. Louis, and his colleagues, reveal a deeper reality: that such adaptations have evolved independently on the separate islands. The Jamaican twig anole is more closely related to other Jamaican anoles —such as the Jamaican giant anole (A)—than to the similar twig anoles on other islands. Specialized anoles native to Hispaniola (E and F) and to Jamaica (dangling, opposite) are likewise not closely related to parallel specialists on other islands. The lesson: Although variations occur randomly, similar ecological circumstances sometimes yield uncannily similar adaptations.

Skeptics of evolutionary theory as
Can it be observed in the wild? Can it be measured i

(Continued from page 21) its method of replicating itself involves a high rate of mutation, and those mutations allow the virus to assume new forms. After just a few years of infection and drug treatment, each HIV patient carries a unique version of the virus. Isolation within one infected person, plus differing conditions and the struggle to survive, forces each version of HIV to evolve independently. It's nothing but a speeded up and microscopic case of what Darwin saw in the Galápagos—except that each human body is an island, and the newly evolved forms aren't so charming as finches or mockingbirds.

Understanding how quickly HIV acquires resistance to antiviral drugs, such as AZT, has been crucial to improving treatment by way of multiple-drug cocktails. "This approach has reduced deaths due to HIV by severalfold since 1996," according to Palumbi, "and it has greatly slowed the evolution of this disease within patients."

Insects and weeds acquire resistance to our insecticides and herbicides through the same process. As we humans try to poison them, evolution by natural selection transforms the population of a mosquito or thistle into a new sort of creature, less vulnerable to that particular poison. So we invent another poison, then another. It's a futile effort. Even DDT, with its ferocious and long-lasting effects throughout ecosystems, produced resistant house flies within a decade of its discovery in 1939. By 1990 more than 500 species (including 114 kinds of mosquitoes) had acquired resistance to at least one pesticide. Based on these undesired results, Stephen Palumbi has commented glumly, "humans may be the world's dominant evolutionary force."

Among most forms of living creatures, evolution proceeds slowly—too slowly to be observed by a single scientist within a research lifetime. But science functions by inference, not just by direct observation, and the inferential sorts of evidence such as paleontology and biogeography are no less cogent simply because they're indirect. Still, skeptics of evolutionary theory ask: Can we see evolution in action? Can it be observed in the wild? Can it be measured in the laboratory?

The answer is yes. Peter and Rosemary Grant, two British-born researchers who have spent decades where Charles Darwin spent weeks, have captured a glimpse of evolution with their long-term studies of beak size among Galápagos finches. William R. Rice and George W. Salt achieved something similar in their lab, through an experiment involving 35 generations of the fruit fly *Drosophila melanogaster.* Richard E. Lenski and his colleagues at Michigan State University have done it too, tracking 20,000 generations of evolution in the bacterium *Escherichia coli.* Such field studies and lab experiments document anagenesis—that is, slow evolutionary change within a single, unsplit lineage. With patience it can be seen, like the movement of a minute hand on a clock.

Speciation, when a lineage splits into two species, is the other major phase of evolutionary change, making possible the divergence between lineages about which Darwin wrote. It's rarer and more elusive even than anagenesis. Many individual mutations must accumulate (in most cases, anyway, with certain exceptions among plants) before two populations become irrevocably separated. The process is spread across thousands of generations, yet it may finish abruptly—like a door going *slam!*—when the last critical changes occur. Therefore it's much harder to witness. Despite the difficulties, Rice and Salt seem to have recorded a speciation event, or very nearly so, in their extended experiment on fruit flies. From a small stock of mated females they eventually produced two distinct fly populations adapted to different habitat conditions, which the researchers judged "incipient species."

After my visit with Douglas Futuyma in Ann Arbor, I spent two hours at the university museum there with Philip D. Gingerich, a paleontologist well-known for his work on the ancestry of whales. As we talked, Gingerich guided me through an exhibit of ancient cetaceans on the museum's second floor. Amid weird skeletal shapes that seemed almost chimerical (some hanging overhead, some in glass cases) he pointed out significant features and

CAN WE SEE EVOLUTION IN ACTION? the laboratory? The answer is yes.

described the progress of thinking about whale evolution. A burly man with a broad open face and the gentle manner of a scoutmaster, Gingerich combines intellectual passion and solid expertise with one other trait that's valuable in a scientist: a willingness to admit when he's wrong.

Since the late 1970s Gingerich has collected fossil specimens of early whales from remote digs in Egypt and Pakistan. Working with Pakistani colleagues, he discovered *Pakicetus*, a terrestrial mammal dating from 50 million years ago, whose ear bones reflect its membership in the whale lineage but whose skull looks almost doglike. A former student of Gingerich's, Hans Thewissen, found a slightly more recent form with webbed feet, legs suitable for either walking or swimming, and a long toothy snout. Thewissen called it *Ambulocetus natans*, or the "walking-and-swimming whale." Gingerich and his team turned up several more, including *Rodhocetus balochistanensis*, which was fully a sea creature, its legs more like flippers, its nostrils shifted backward on the snout, halfway to the blowhole position on a modern whale. The sequence of known forms was becoming more and more complete. And all along, Gingerich told me, he leaned toward believing that whales had descended from a group of carnivorous Eocene mammals known as mesonychids, with cheek teeth useful for chewing meat and bone. Just a bit more evidence, he thought, would confirm that relationship. By the end of the 1990s most paleontologists agreed.

Meanwhile, molecular biologists had explored the same question and arrived at a different answer. No, the match to those Eocene carnivores might be close, but not close enough. DNA hybridization and other tests suggested that whales had descended from artiodactyls (that is, even-toed herbivores, such as antelopes and hippos), not from meat-eating mesonychids.

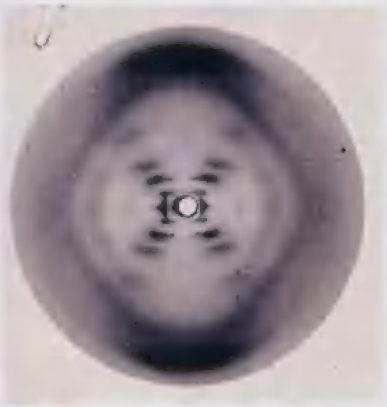
In the year 2000 Gingerich chose a new field site in Pakistan, where one of his students found a single piece of fossil that changed the prevailing view in paleontology. It was half of a pulley-shaped anklebone, known as an astragalus, belonging to another new species of whale. A Pakistani colleague found the fragment's other half. When Gingerich fitted the two pieces together, he had a moment of humbling recognition: The molecular biologists were right. Here was an anklebone, from a four-legged whale dating back 47 million years, that closely resembled the homologous anklebone in an artiodactyl. Suddenly he realized how closely whales are related to antelopes.

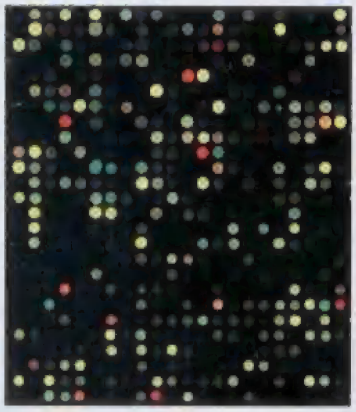
This is how science is supposed to work. Ideas come and go, but the fittest survive. Downstairs in his office Phil Gingerich opened a specimen drawer, showing me some of the actual fossils from which the display skeletons upstairs were modeled. He put a small lump of petrified bone, no larger than a lug nut, into my hand. It was the famous astragalus, from the species he had eventually named *Artiocetus clavis*. It felt solid and heavy as truth.

Seeing me to the door, Gingerich volunteered something personal: "I grew up in a conservative church in the Midwest and was not taught anything about evolution. The subject was clearly skirted. That helps me understand the people who are skeptical about it. Because I come from that tradition myself." He shares the same skeptical instinct. Tell him that there's an ancestral connection between land animals and whales, and his reaction is: Fine, maybe, but show me the intermediate stages. Like Charles Darwin, the onetime divinity student, who joined that round-the-world voyage aboard the *Beagle* instead of becoming a country parson, and whose grand view of life on Earth was shaped by close attention to small facts, Phil Gingerich is a reverent empiricist. He's not satisfied until he sees solid data. That's what excites him so much about pulling whale fossils out of the ground. In 30 years he has seen enough to be satisfied. For him, Gingerich said, it's "a spiritual experience."

"The evidence is there," he added. "It's buried in the rocks of ages."

HOW DO YOU ILLUSTRATE EVOLUTION? Watch Robert Clark's photographic concept unfold in a multimedia feature. Then join our forum and share your thoughts on "Was Darwin Wrong?" at nationalgeographic.com/magazine/0411.

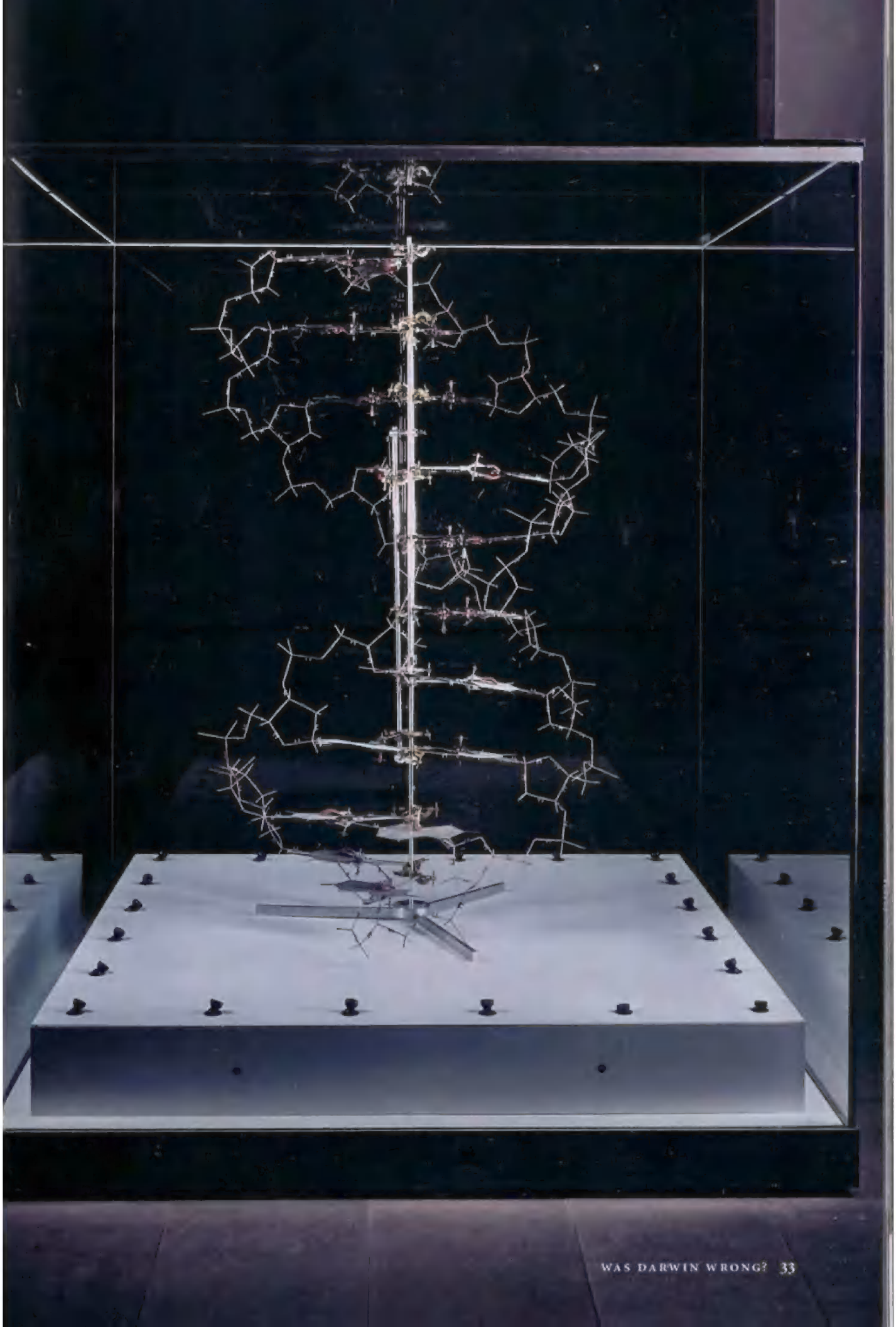


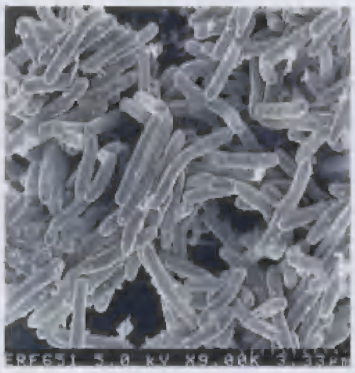


The Genetic Revolution

Gregor Mendel (top), an Austrian monk, discovered the fundamentals of genetics in Darwin's time, but his ideas, published in an obscure journal, were ignored. Later biologists merged evolutionary theory with genetics, though they still didn't understand how genetic information was stored in a molecule. Rosalind Franklin's 1952 x-ray diffraction photo of DNA (above) helped James Watson and Francis Crick solve the molecule's double-helix structure (opposite). The new field of genomics uses information technology such as the DNA chip (above right), charting the relationships among such different species as the fruit fly *Drosophila melanogaster* (middle), chimpanzee (hand at bottom), and ourselves. We've come a long way since Darwin looked for evidence in his pigeon coop.

PAINTING PHOTOGRAPHED BY STEPAN BARTOS AT MENDEL MUSEUM, BRNO, CZECH REPUBLIC. DNA X-RAY: VALLEY LIBRARY, SPECIAL COLLECTIONS, OREGON STATE UNIVERSITY; REPRINTED BY PERMISSION FROM *NATURE*, 25 APRIL 1953. DNA CHIP: BOB WALKER, NATIONAL INSTITUTES OF HEALTH. FLY: MATTHEW RONSHAUGEN AND WILLIAM McGINNIS. HAND PHOTOGRAPHED AT NORTH CAROLINA ZOO, ASHEBORO. DOUBLE HELIX PHOTOGRAPHED AT SCIENCE MUSEUM, LONDON





MEDICAL RESEARCH

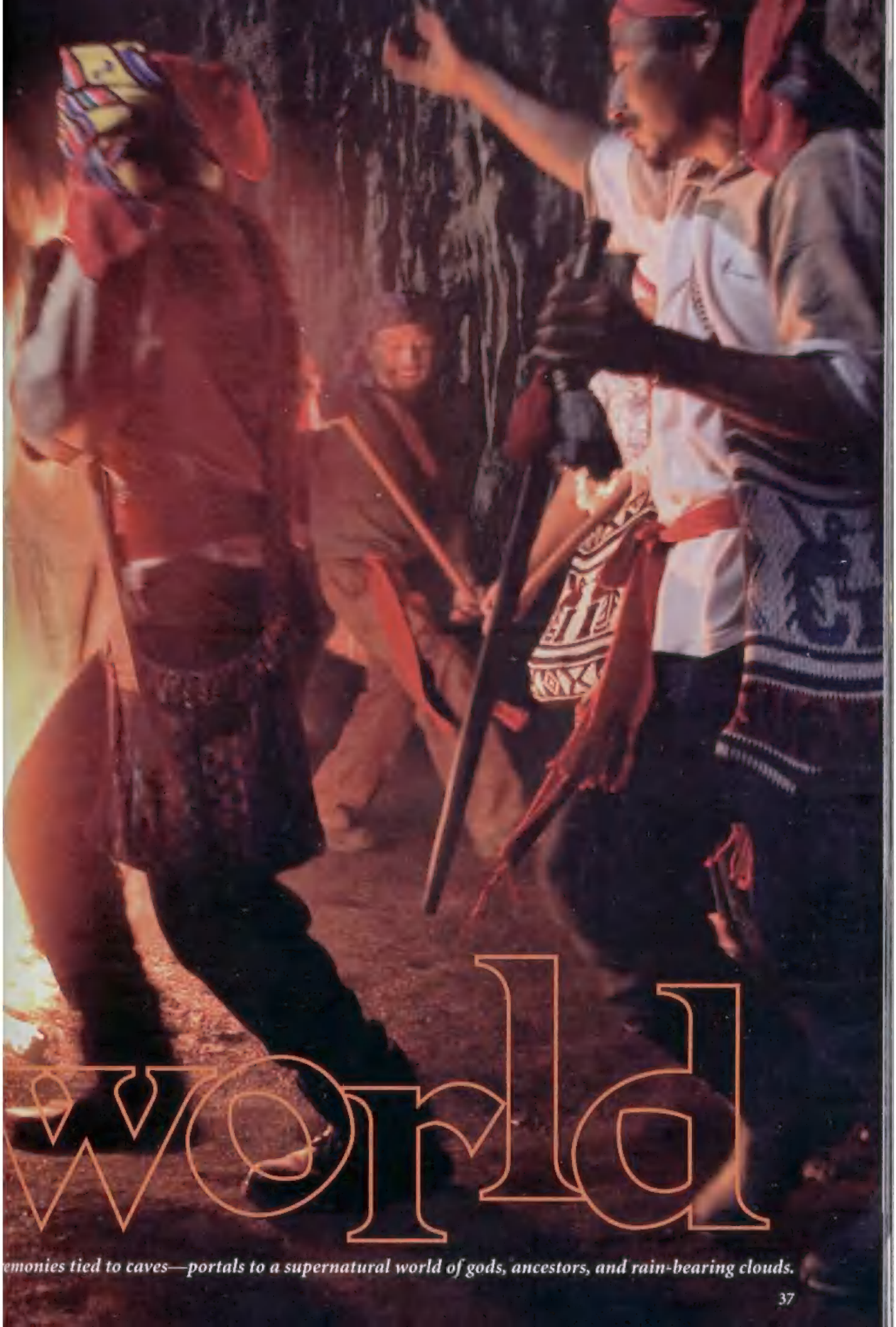
How Evolution Touches You

Bacteria and viruses evolve too. Infectious agents such as *Mycobacterium tuberculosis* (top right), the bacterium that causes tuberculosis, adapt quickly and acquire genetic resistance to drugs. Evolutionary theory underlies the work of medical researcher Barry Kreiswirth (opposite)—holding the chest x-ray of a TB-infected patient—in his studies of drug-resistant TB. Laboratory mice (above right) serve as research models because, sharing our mammalian ancestry, they also share a large proportion of our DNA. Peter Kibisov (above), a former convict in Russia, carries two enduring remnants from his prison time: a Crucifixion tattoo and drug-resistant TB. He hopes God will help him, but evolution-based science is what guides the search for an earthly cure. □

CLIFTON BARRY AND ELIZABETH FISCHER, NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS DISEASES, NATIONAL INSTITUTES OF HEALTH (BACTERIUM)

descent into the maya underworld

Inspired by beliefs more than 2,000 years old, a Maya farming community in Guatemala fires up one of ma



world

emonies tied to caves—portals to a supernatural world of gods, ancestors, and rain-bearing clouds.

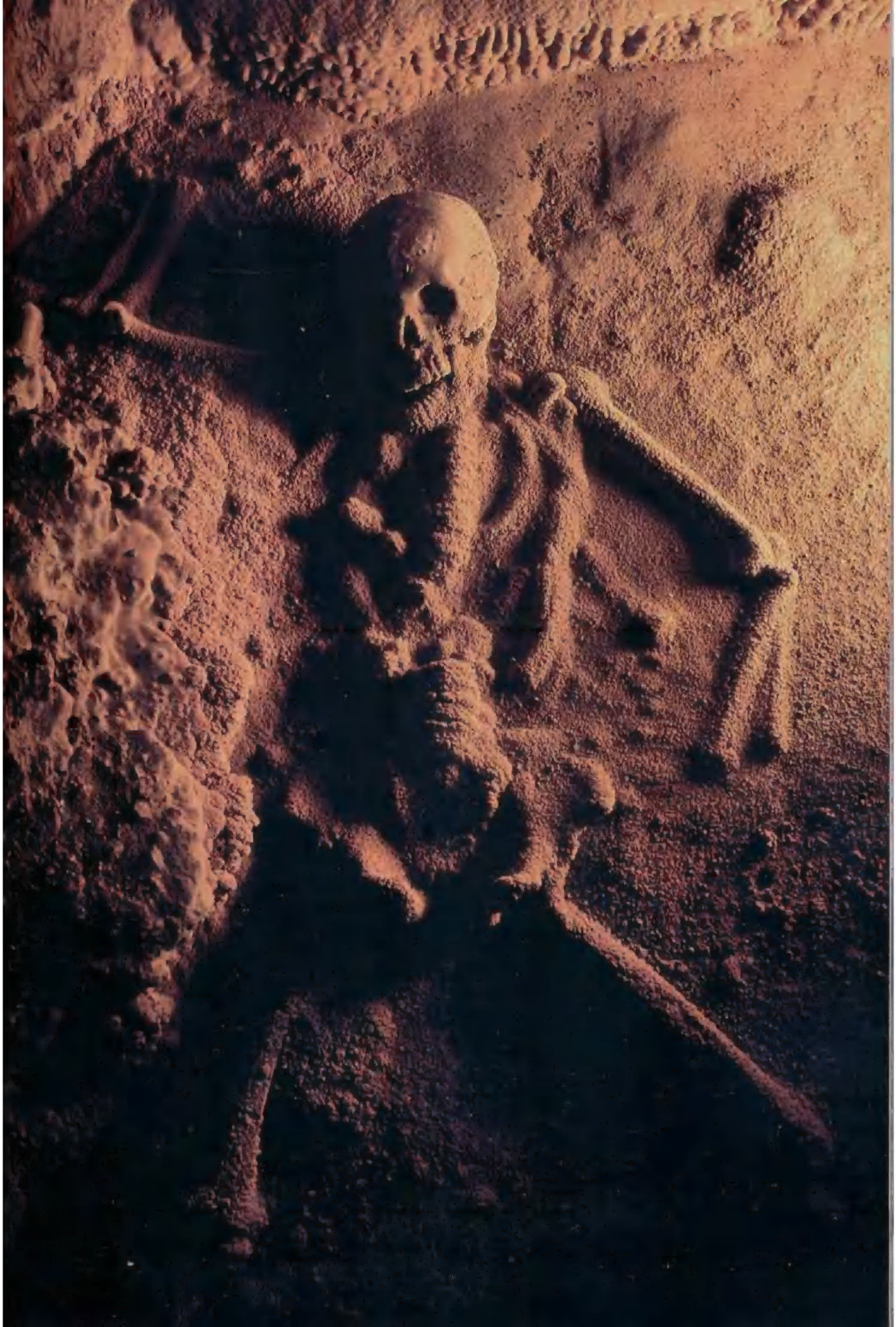
By David Roberts Photographs by Stephen L. Alvarez

We had scarcely gone 200 yards into the Guatemalan forest, 20 of us weaving single file along the faint path behind our machete-wielding guide, when Diego Faustino Chávez warned us about a certain kind of bejuco, or vine. "If you step over it," he said to anthropologist Allen Christenson, "you can disappear. Or you think you've been gone for a few seconds, but it's really been three days."

We had already been told that if a snake or a jaguar or an owl crossed our path, we would have to turn around at once and go back to town. Now, the leaders of our pilgrimage marched up the hillside with hypervigilant care, alert to any of these omens that might prove it was unsafe to approach our distant goal. Five of our group were *gringos*, including Christenson, photographer Stephen Alvarez, and me. The rest were Tz'utujil Maya from the nearby town of Santiago Atitlán. Our leaders were the machete-wielding guide; Diego, an aristocratic Santiago entrepreneur; and an *ajq'ij* named Juan, one of only a handful of ajq'ijs among the Tz'utujil. More than a shaman, an ajq'ij is a day keeper (the term translates literally as "he

Perhaps a sacrifice to Chac, the rain god, around A.D. 850, a young woman turns to stone as minerals encase her bones (right) in a cave in what is now Belize. During a traditional rainmaking ritual in Santiago Atitlán, Guatemala, a* nabeysil, *or priest, prays in a building that symbolically becomes a cave.

PHOTOGRAPHED WITH PERMISSION OF BELIZE INSTITUTE OF ARCHAEOLOGY (RIGHT)



of the day"), an initiate into the ancient mysteries of the Maya calendar, in which every day has a plethora of supernatural signs and overtones.

The goal of our pilgrimage was a remote cave called Paq'alibal. For the Tz'utujil, Paq'alibal is arguably the most sacred place in the universe, for it is the cave in which dwell the *nuwals*, deified ancestors who bless the world with rain and fertility. So dangerous was it to approach the cave unprepared, the Maya believe, that in Santiago several shamans had been performing ceremonies since August to ensure that the nuwals would welcome us. Christenson had been doing fieldwork in Santiago since 1988 and had learned about Paq'alibal early on; but it had taken 15 years for him to earn the trust of the Santiago shamans that now made our trek possible.

November 3, chosen by the ajq'ijs as the proper day for our pilgrimage, was named *K'at* in the Maya calendar, and for Juan that was not a good sign. Among K'at's deeper meanings were "to burn," "in nets," and "touchy" or "delicate." As Christenson had forewarned me, " 'Touchy' is self-evident. But we could also be caught, as in a net. Another meaning has to do with the process of degraining maize. We could be pulled out at any moment, like a kernel of corn."

Our guide was setting so frantic a pace up the steep trail that it was all Stephen and I, who thought we were in pretty good shape, could do to keep up. We learned later that a barely controlled terror was dictating his pace. At one point he had seen the trees on either side of him start to tremble, despite there being not a breath of wind. As Diego later explained, "He was afraid of being betrayed. If we went up there in

If we went against tradition

Two faiths merge in Tila, Mexico, during an annual festival that involves Catholic rites and a pre-Columbian pilgrimage. After attending Mass in town, worshippers from around the country (left) hike up a sacred mountain. In a cave shrine at the top Maya men light candles and pray before a stalagmite formation symbolizing the Black Christ, a fusion of Jesus and an ancient Maya god.

bad faith, he would get in serious trouble with the ancestors. If we went against the traditions, he feared for his very life."

In an hour we had climbed 1,500 feet above Lake Atitlán, whose glistening surface we glimpsed now and then through holes in the canopy. But the ajq'ij had heard a woodpecker singing on the left side of our column. A woodpecker on the right would have been all right, but a woodpecker on the left—the dark, female side—was a very bad omen.

Far above the lake we crossed a high ridge and immediately plunged into thick clouds. I felt completely disoriented: We seemed to be hiking through a limitless tangle of branches and leaves. Now, from Tz'utujil mutterings translated into Spanish and then into English, I learned that the Maya believed that the trail had suddenly and mysteriously stretched itself out for hundreds of yards. Diego paused beside our column, a finger to his lips demanding silence. We were almost in sight of the cave, he whispered to Christenson.

But we would not be allowed to visit Paq'alibal after all. There had been too many inauspicious signs.

That didn't mean that our day was over, however. In an utterly nondescript patch of forest, a piece of cloud-smothered ridge that seemed detached from Earth itself, we halted. The Maya celebrants unloaded their packs. Under the ajq'ij's careful direction, the Tz'utujil began laying out the paraphernalia for a ritual that would last for four hours.

TO THE MAYA a cave is a portal to the underworld—to what some Maya call Xibalba, the Place of Fright. In the Maya cosmos, Xibalba is a complex realm, the dwelling place of monstrous supernatural beings but also the source of life-giving rain and corn, and the home of the beloved dead.

Today's Maya, who number perhaps seven and a half million people, occupy a region stretching from Mexico's Yucatán Peninsula to northern El Salvador and Honduras; although culturally a single people, they speak 30-odd languages. They trace their ancestry back at least as far as 2000 B.C. From about A.D. 250 to 900, the Classic era, they aggregated in cities of as many as 90,000 people, built lordly pyramids such as those that still stand at Tikal, Copán, Palenque, and Calakmul, and erected tall stone monuments, or stelae, to glorify their kings. During this period the Maya perfected the most complex writing system invented in the pre-Columbian New World. Then some monumental catastrophe struck the Maya world in the ninth century. The great cities were abandoned; the Maya stopped inscribing the stelae with rich hieroglyphic texts. A second great rupture occurred with the Spanish conquest after 1524. By the 18th century even the wisest Maya elders had lost the knowledge of the hieroglyphs, which scribes had stopped writing more than a century before.

As far back as archaeologists can trace the culture, there is evidence of the profound importance of caves in Maya life. Yet though outsiders have been studying Maya civilization since the memorable voyages of John Lloyd Stephens and Frederick Catherwood in the mid-1800s, most remain ignorant of the Maya underworld. Cave rituals and pilgrimages have been performed by the Maya at least as far back as the time of Christ, yet it was not until 1959 that any were documented.

On September 15 of that year, José Humberto Gómez, a Mexican tour guide, was prowling

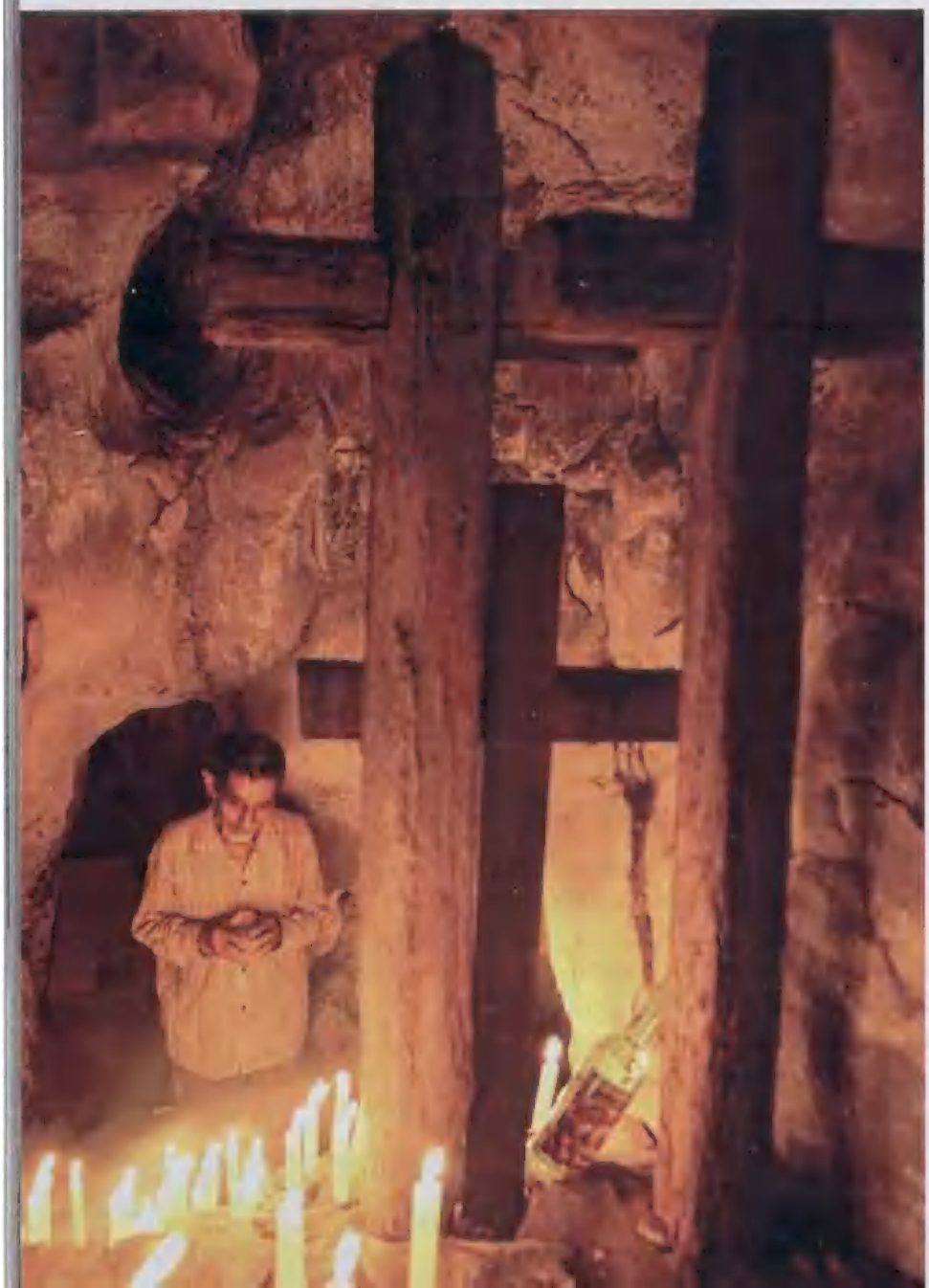
ur guide feared for his very life.

through the cave of Balankanche, near Chichén Itzá in Yucatán. The cave had long been known and, it was thought, thoroughly explored; only a few potsherds scattered along the main passageway testified to an ancient Maya presence. Suddenly Gómez noticed that a patch of wall was unnatural. Scraping away the mud, he uncovered a small portal sealed with clay.

Gómez chipped away the clay and crawled through a hole, emerging in a tunnel. A hundred yards on he came to a large chamber dominated by a column of limestone reaching from floor to ceiling. What Gómez saw astonished him. On the slimy cave floor was a dazzling assemblage of brightly painted clay vessels. Many were incense burners shaped as effigies of the rain god Tlaloc, whose grotesque, sneering face was molded in bas-relief on the clay itself. News of the find soon reached a nearby archaeological team. That team, led by E. Wyllys Andrews IV and sponsored in part by the National Geographic Society, performed an extensive survey of the cave.

Forty-four years later, on a miserably hot day in July, I took the hourly guided tour of Balankanche. Even though the cave is now tamed with electric lights and boardwalks, a sign in Spanish at the entrance warns anyone with cardiac or respiratory problems (as well as *nerviosas* and *claustrofóbicas*) not to enter. Three hundred yards in, we stepped through a gateway, a tourist-friendly portal enlarged from Gómez's crawlway, then hiked down the tunnel to the room with the column. There, I leaned against a wooden railing and stared. My breath came in shallow gasps—partly because of the fetid air and partly because of what I saw.

The 1959 team had left the objects they found in situ. The painted Tlaloc effigy pots still lay all around the column—not replicas, but the original vessels. About a thousand years ago the local Maya had performed elaborate rites in this secret lair so near the underworld. Tlaloc, moreover, was originally not a Maya but a central Mexican



In every corner of the Maya realm, caves show evidence of their ancient ceremonial role, including sacrificial remains, wall paintings, and pottery offerings. Some sites continue in use. Near Joloniel, Mexico, in a cave with murals from about A.D. 300, a ritual leader prays for rain (left). Each cross symbolizes Christianity as well as the intersection of the natural and supernatural Maya worlds. After the Spanish conquest many Christian and Maya symbols were linked, creating a unique form of Catholicism.

god. By appealing to this deity, rather than the Maya rain god, Chac, the Balankanche worshippers had demonstrated a close affiliation (only dimly suspected before 1959) with civilizations more than 800 miles away, north of today's Mexico City. Had Tlaloc failed them? For whatever reason, the Maya had sealed shut the shrine—no doubt forever, they hoped, for they had taken pains to camouflage the portal. Yet a faint memory of the lost shrine has perhaps come down through the centuries in the name of the cave. Balankanche translates as "throne of the jaguar" but can also mean "hidden throne."

Not long after the archaeologists entered the cave in 1959, Romualdo Ho'il, the *hmen,* or shaman, from the nearby town of Xcalakoop, told them he wasn't happy. At the time, George Stuart was a 24-year-old surveyor on the team; today the distinguished archaeologist, recently retired from National Geographic, is one of only two members of that party still alive. Stuart recalled the hmen's anger: "We had violated the cave. My wife and Andrews's wife had been inside, and taking women in was really bad. They—Ho'il and his assistants—would have to perform a ceremony, not only to purify the cave, but to protect us from serious harm."

Ho'il had a long list of goods for the ceremony, which he named the Reverent Message to the Lords. It included 13 chickens, 13 black candles made from wild bee honeycomb, leaf tobacco, bottles of the fiery alcohol aguardiente, garlic buds, black pepper, cumin seeds, and corn. On October 17, 1959, the team, along with Ho'il and his sizable Maya retinue, descended into Balankanche. The ritual would last almost 20 hours.

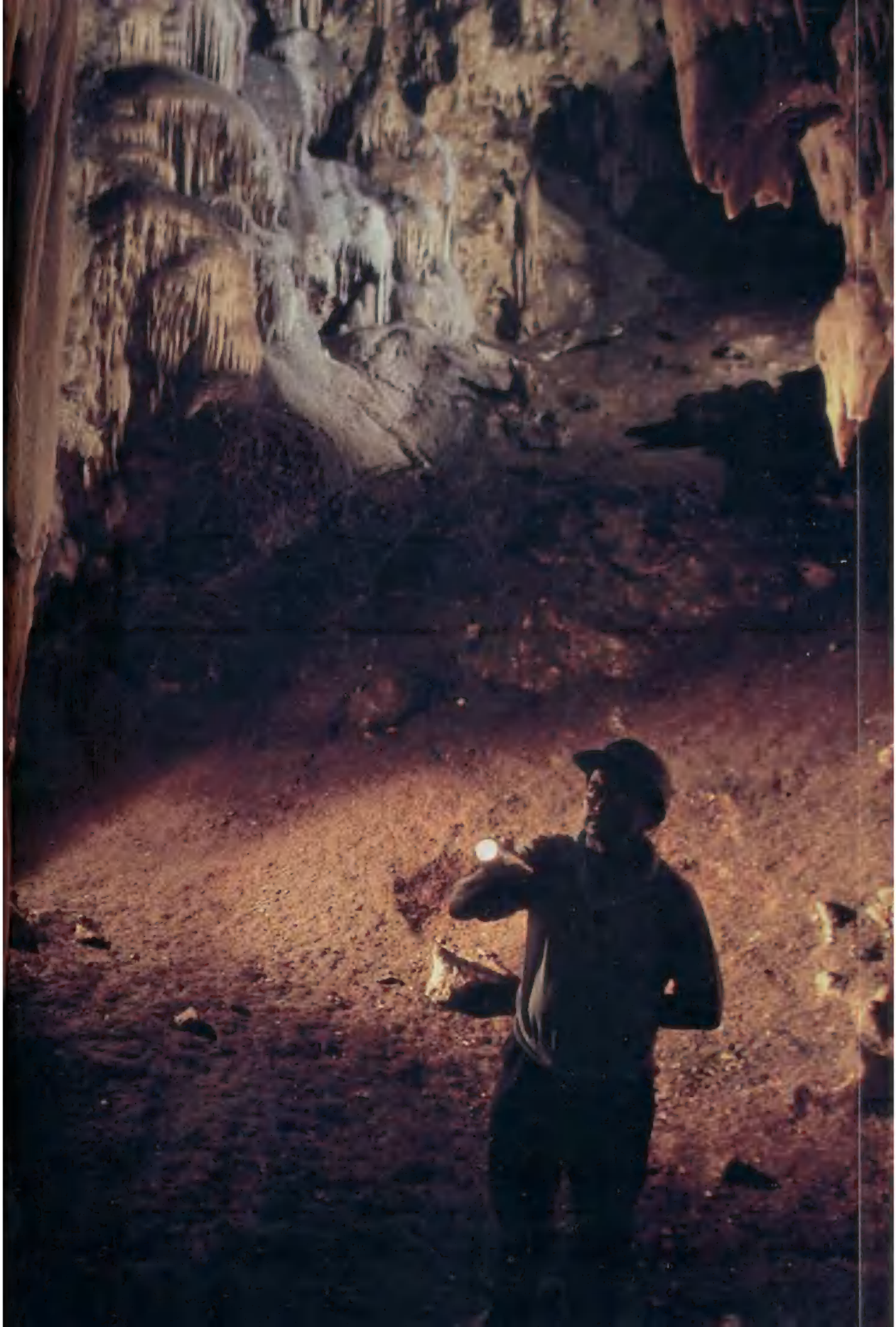
More than four decades later I sat in Stuart's study and listened to a wire recording of the ceremony. The shaman had drunk *balche',* a mildly intoxicating beverage, almost nonstop. But now, hours into the ritual, his voice rang clearly, a hypnotic stream of Maya syllables chanted on a single tone. At times he paused to imitate the guttural groan of the jaguar. In the background young boys mimicked the croaking of frogs.

Even for the gringos, who mostly sat and watched, the vigil was exhausting. The air was stiflingly close. But by morning Romualdo Ho'il had succeeded in purifying Balankanche of its profanation by Gómez and the archaeologists. What may have been the first Maya cave ritual ever witnessed by outsiders was complete.

IN A FAR DIFFERENT part of the Maya world Stephen Alvarez and I watched a ceremony with many elements strikingly similar to the one at Balankanche. On the ridge far above Lake Atitlán, the Maya celebrants changed into traditional dress—red shirts and white pants embroidered with bird patterns. Out of their packs they pulled three guitars, a violin with only three twine strings, a pair of maracas, a big skin-headed drum, and a *tun,* a drum made out of a split hollowed log. The musicians, including Juan himself, tuned up and began to play. In this ensemble, a careless ear might have heard a mariachi band enlivening some picnic in the woods, except that Allen Christenson informed us that most of the songs were hymns of supplication to someone named Francisco Sojuel.

"Who's he?" I whispered. "He's the principal culture hero of the region," Christenson whispered back. "He represents all the nuwals in the cave." "When did he live?"

Christenson smiled. "Francisco Sojuel lived either at the time of Creation, or at the time of the Spanish conquest, or at the end of the 19th century—or all of the above."



On a rare visit to Naj Tunich cave in Guatemala, a guard spotlights ancient glyphs. A pilgrimage site from at least 100 B.C. to A.D. 900, the cave was permanently gated in the 1980s after vandals defaced its walls. In the fall farmers now celebrate the harvest at the cave's entrance.

Earlier the ajq'ij had cleared a patch of ground, then covered it with pine needles to improvise an altar. Men cooked tortillas and an egg-and-tomato meal over a small fire. A jug of aguardiente was passed around. Each of us had to down a jigger of the stuff in one gulp. Then the ajq'ij censed each of us by waving a can full of smoking copal about our bodies.

Now the ajq'ij laid out the offerings to the ancestors on his makeshift altar. He placed a pile of slender white candles in the center, then surrounded them with corn kernels in a plastic bag, cigarettes and matches, and a paper plate laden with the food. At the corners of the altar he placed four full aguardiente bottles, with a beer bottle next to the right-hand liquor flask. I sneaked out my compass. To my astonishment, in this cloud-blinded hollow in the forest, the ajq'ij had somehow placed the bottles exactly at the points of the four cardinal directions, with the beer-and-liquor pairing to the east, the most sacred direction.

The lilting, ballad-like music went on and on. We were all offered food and entreated to down yet more aguardiente. The ajq'ij himself had drunk far more than anyone else. Now he placed half the candles upright, digging little holes in the earth to support them, the whole design making a dotted square divided into four quadrants. Among the candles he placed cigarettes, half also upright. Then he lit the upright candles and cigarettes. At one point a candle drooped toward an unlit cigarette. One of the other men started to right it, but Juan stopped him with an urgent gesture. As we watched, the candle dipped by itself and lit the cigarette. This, we learned later, was the best possible sign, indicating that the ancestors, who "eat light," were accepting the offering.

After two hours the ajq'ij knelt before the altar and began to chant. The monotonic stream of run-on syllables in Tz'utujil bore an uncanny resemblance to the shaman's invocations on the 1959 recording. The ajq'ij's endurance was formidable, as he chanted for 20 minutes, staring east, deep in trance, his upturned hands kneading the air.

At last, one by one, the other men took Juan's place, kneeling before the altar. Standing beside each supplicant, the ajq'ij filled his own mouth with aguardiente, then blessed the man by spitting a fine spray over his head. At the end of the

creation

myth of the hero twins

ART BY JOHN JUDE PALENCAR

In the Maya view of the cosmos, caves are openings to the water-filled underworld—Xibalba, or the Place of Fright—which plays a key role in the story of creation as described in the Popol Vuh, *a sacred book of the Maya.*

The legend tells of twin brothers who were skilled at a traditional ball game. As they played, they made so much noise they disturbed the gods of Xibalba, who challenged them to a contest. The gods defeated the twins, sacrificed them, and buried their bodies under the ball court. The head of one brother, Hun Hunahpu, was hung on a tree of humanlike calabash gourds. A goddess named Xquic heard of the strange tree and decided to see it for herself. When she approached, Hun Hunahpu's head spat into her hand (above), impregnating her with Hunahpu and Xbalanque, the brothers known as the Hero Twins. In time the twins became ball players like their

father and uncle. Summoning them to a contest in Xibalba, the gods defeated them, ground up their bones, and threw them into a river. There the Hero Twins were reborn, first as fish and then as itinerant performers.

Returning to Xibalba for revenge, they contrived an ingenious trap. After they demonstrated a variety of astonishing feats, Xbalanque beheaded Hunahpu—and then made him whole again. The gods were so delighted with this display that they begged to be sacrificed and then revived as well. The Hero

Twins appeared happy to oblige and began to dismember the gods (below). In the end they delivered the ultimate blow: Refusing to restore them to their original state, they defeated the gods once and for all. With good thus triumphing over evil, the Earth was now ready for the creation of human beings.

Xbalanque and Hunahpu emerged from Xibalba as the sun and the moon (far left, bottom)—gifts to the Maya—and rose into the sky. Each day they reenact their journey to the underworld and their joyful return.

ritual the ajq'ij poured a can of pineapple juice on the ground, to each of the four directions.

The men embraced, giddy with happiness. All the candles had burned flush to the ground—another propitious sign. But as we loaded our packs to start the long hike back to Santiago, Stephen and I were still disappointed that we had not been allowed to go to Paq'alibal. Then Christenson told us the good news.

The ajq'ij had determined that the nuwals had been so pleased with the offering, it would be safe to go the next day. Even as I rejoiced at this second chance, I blanched at the thought of repeating the grueling hike. Not to worry, Christenson said: We had followed the ancient ceremonial route to Paq'alibal. The success of our ceremony meant that tomorrow we could take the shortcut.

SINCE THE DISCOVERY of the hidden throne at Balankanche, archaeologists have found potsherds, rock art, and stone altars dating back to before the time of Christ inside underground grottoes all over the Maya world. Whether the ceremonies that left behind these vestiges were anything like those of today's Maya remains an unanswered question. But sometimes the artifacts are so rich, we can reconstruct the ritual that produced them.

One such ritual took place on a day in the second half of the ninth century A.D., as a group of Maya gathered before the hourglass-shaped mouth of a cave deep in the rain forest of what is today highland Belize, about 215 miles northeast of Paq'alibal. The celebrants carried huge orange and brown pots, grinding stones hewn from granite, copal to burn, and corn to offer.

Our goal: Paq'alibal, the most

Spraying liquor, a spiritual guide purifies a participant in a ritual that asks ancestors for permission to visit a Guatemalan cave called Paq'alibal. The pilgrims completed their journey the following day. More than a millennium ago, a visitor to a cave in Belize left the ghostly outline of a hand (below).

PHOTOGRAPHED WITH PERMISSION OF BELIZE INSTITUTE OF ARCHAEOLOGY

The priests waded into the stream rushing from the mouth of the cave, then, holding high their flaming pine torches, swam across the blue entrance and into the dimness beyond. The rest of the entourage followed. Among them was a woman, about 20, who would not emerge from the underground.

Slowly the procession wound into the realm of perpetual night. The supplicants pushed deeper, clambering over giant boulders, squeezing through keyhole slots, wading chin deep against the current. Their torches gave off a smoky orange glow, too faint to reach the ceiling above, from which daggers of slow-dripping calcite hung like portents.

Far into the cave, the pilgrims climbed onto a high shelf of limestone. The sound of the river faded below them. At last they gained a broad terrace where dams formed by thin stone ridges sectioned off dry pools. They laid down the things they had so arduously carried to this remote sanctum. As one torch guttered, they used it to light another. The priests prepared their invocations.

Another season had come and gone without a drop of rain. For reasons no one could fathom, Chac, the Maya rain god, had chosen to afflict the people. Some had already starved, and there was talk in the plazas about leaving the homeland for good, to wander north or west in search of reprieve. But if there was anything the people might do that could persuade Chac to relent, that could restore the world to the glory their forefathers had known, it was the deeds these celebrants would perform during the next several hours.

More than 11 centuries later Stephen Alvarez and I were guided into the same cave—Actun Tunichil Muknal, or the Cave of the Stone Sepulchre—by Jaime Awe, a Belizean archaeologist. We too swam across the entrance pool, waded chest deep in the rushing stream (as unseen fish nibbled at our legs), then climbed a steep and slippery rubble pile.

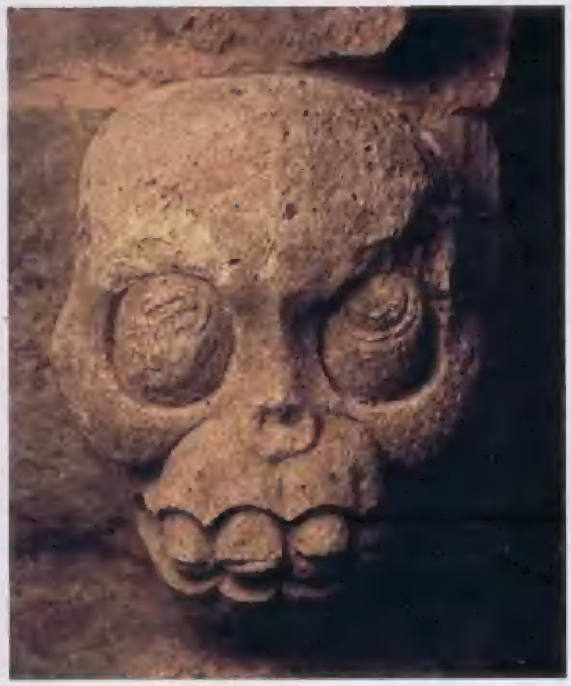
Eight hundred yards and almost two hours in, we reached the spacious chamber at the heart of the cave. Two hundred ceramic pots lay scattered about, most of them whole or nearly whole, some arranged in natural niches as if placed in museum display cases. The shock

acred place in the universe.

came, however, as we gazed upon our first skeleton—one of 14 Awe has found in the cave. "This is a human sacrifice," he said. During the next several hours we hovered over one victim after another, including one pile of tiny bones, all that was left of an infant. The most startling skeleton was that of the 20-year-old woman. She lay sprawled in the position of her death, legs and arms akimbo, as some priest had either slit her throat, cut her heart out, or disemboweled her. The skull, staring upward at eternity, seemed frozen in a silent scream.

Awe believes the skeletons were sacrifices to Chac. "Earlier the Maya had implored Chac near the entrances to the caves," he said. "But by the middle of the ninth century, something wasn't working. The rain never came. So the Maya went deeper and deeper into the caves, making more and more desperate petitions to Chac. This is what they left."

Even these prayers failed. Within 50 years the Classic civilization had collapsed and the center of Maya culture moved north to the Yucatán Peninsula. Actun Tunichil Muknal slept with its dark secrets for more than 1,100 years, until a small group of die-hard cavers in the 1980s rediscovered the portal deep in the Belize rain forest.



The Maya believe corn was born in a mythical mountain cave, re-created as a temple (right) at the ceremonial site of Copán in Honduras. On a nearby building a skull symbolizes access to the underworld. Such sacred concepts, expressed in ancient architecture, endure in the living Maya culture.

ON OUR SEARCH for Paq'alibal, we headed once more up a faint path near Santiago Atitlán through the forest. From close by came the sharp reports of men, invisible in the jungle, chopping at trees with axes. Now Juan told the policemen accompanying us to unholster their pistols, for this was a dangerous area: not on account of woodpeckers on the left, but of bandits known to attack locals and tourists alike. I was not reassured to hear the policeman just behind me mutter in response, *"Quien va a morir, va a morir, y quien no, no*—Whoever's going to die is going to die, and whoever isn't, isn't."

After a steep hike of only 15 minutes, we stopped in front of a cliff with a small orifice at ground level. I thought we were taking a rest, until Allen Christenson said, "This is it."

I looked again. *This is the storied Paq'alibal?* I wondered, unable to squelch my disappointment. Sensing my mood, Christenson murmured, "To the Maya, it doesn't matter how big a cave is."

Nothing seemed out of the ordinary. One of the Maya men popped open a can of fruit juice. A policeman wolfed down a pack of soda crackers. Diego's cell phone abruptly rang; he took the call, standing before the cave.

Above the mouth of the grotto, a pole had been affixed horizontally, from which, we learned, celebrants still hang offerings of fruit. Melted candle wax crusted the bedrock on either side of the opening. One by one, we poked our heads inside and crawled a few feet toward the

A young woman's skull

PHOTOGRAPHED WITH PERMISSION OF PARQUE ARQUEOLOGICO COPAN (BOTH)

darkness. The cliff was not limestone but a prickly basalt. The "cave" was little more than an alcove, but in the light of my headlamp, I could see that a level tunnel stretched a remarkable 40 or 50 feet back into the hillside, culminating in what looked like a natural altar. The ajq'ij asked us not to penetrate to that inner sanctum.

I waited for Juan to begin some sort of ceremony, but apparently none was needed. We had completed the propitiatory rites the day before, in that patch of cloud-shrouded ridgeline in the middle of nowhere.

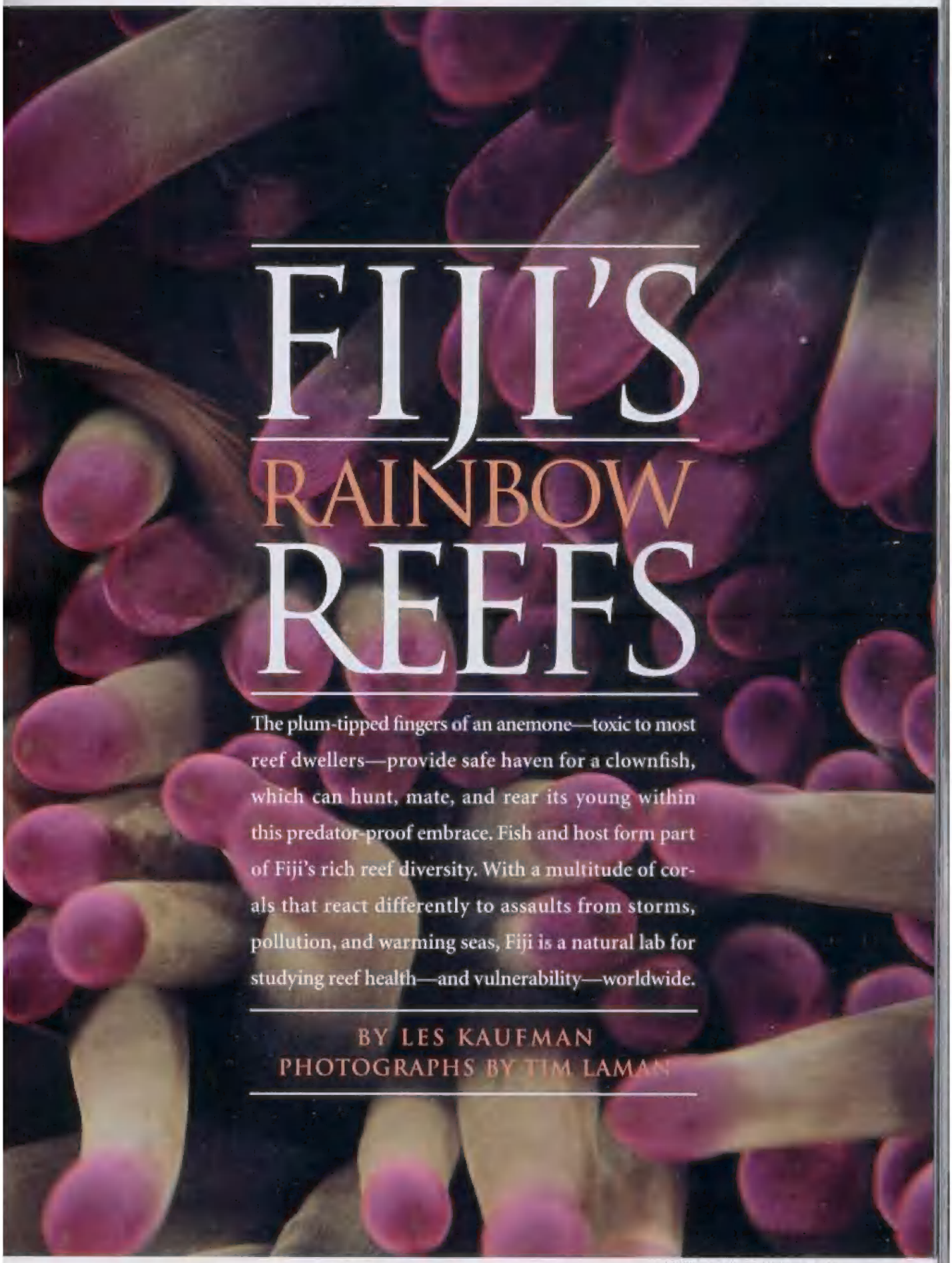
Christenson's face was aglow. After all, he had waited 15 years for this moment. Now he said softly to Stephen and me, "Do you realize that we are the first Anglos ever to visit this place?"

The ajq'ij spoke to the anthropologist in Tz'utujil. Christenson translated: "He says his heart feels happy when he's close to the nuwals. And the nuwals are happy that he brought strangers here who have come here to honor Paq'alibal."

I felt my disenchantment slip away. All my own notions of the sacred, I realized, were based on Christian models—the sermon, the hymnal, the prayer on bended knee. Here in highland Guatemala I had been plunged into the midst of an altogether different conception of the sacred. Without the cave, the hike through the forest, and the days among the Maya, it was a revelation I could never have received. □

LISTEN UP Hear the 1959 recording of the Maya purification rite—"The Reverent Message to the Lords." Then witness the Sights & Sounds of the Maya underworld's creation myth at **nationalgeographic.com/magazine/0411.**

eemed frozen in a silent scream.



FIJI'S RAINBOW REEFS

The plum-tipped fingers of an anemone—toxic to most reef dwellers—provide safe haven for a clownfish, which can hunt, mate, and rear its young within this predator-proof embrace. Fish and host form part of Fiji's rich reef diversity. With a multitude of corals that react differently to assaults from storms, pollution, and warming seas, Fiji is a natural lab for studying reef health—and vulnerability—worldwide.

BY LES KAUFMAN
PHOTOGRAPHS BY TIM LAMAN

CLOWNFISH (*AMPHIPRION PERIDERAION*)

Fins flash as schooling bannerfish stream through Somosomo Strait. "When I swam toward the

SCHOOLING BANNERFISH *(HENIOCHUS DIPHREUTES)*

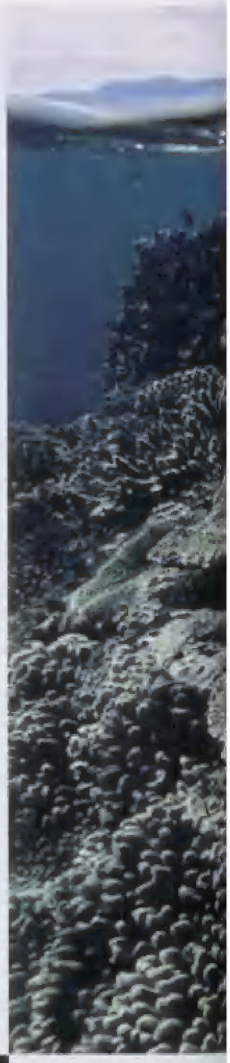
ey didn't scatter," says photographer Tim Laman. "I guess they didn't see me as a threat."

Lacy soft-coral polyps and orange basslets form a vivid wall of mouths gulping plankton funneled i

ORANGE BASSLETS *(PSEUDANTHIAS SQUAMIPINNIS)*

tu-i-Ra Channel by cool-water upwellings. Such food-rich currents help Fiji's reefs thrive.

Fiji's reefs can take a punch and come back swinging. Expert at being both whomped and resilient, these reefs are prime ground for scientists struggling to understand the catastrophic decline of Earth's coral habitats. Though cyclones, disease, predators, and volcanic eruptions all harm reefs, corals tend to regenerate after such natural blows. But the carbon-dioxide-rich atmosphere humanity is brewing, and the resulting rise in sea temperatures, may cripple coral's ability to recover.

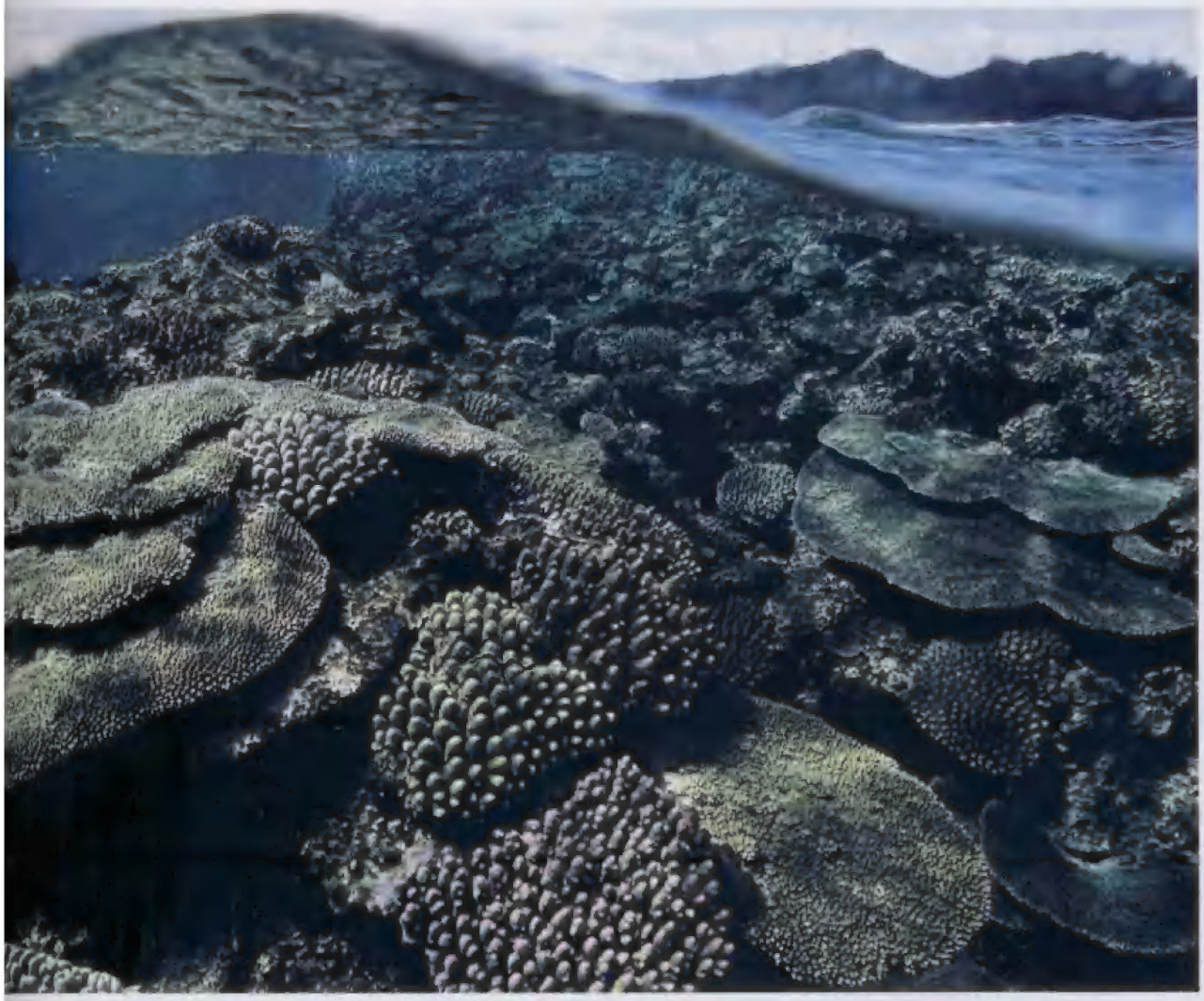


When water heats up, corals expel the symbiotic algae that provide nutrients and color, leaving the corals "bleached." Some scientists theorize that bleaching evolved to help corals adjust to shifting temperature by swapping existing algae for others more heat-hardy. But as global temperatures rise, corals are reaching their upper limits of heat tolerance. In Fiji corals can survive in waters up to about 86°F. Beyond that, it's like asking corals to shift into a gear they just don't have.

Fiji's reefs took a major hot-water hammering in 2000 and 2002, leading to widespread bleaching. As a marine biologist long interested in coral reefs, I joined a recent expedition to Fiji to see how its reefs were faring after the heat waves. We found vast differences from place to place. Stripped of algae, some corals had starved and died, leaving denuded limestone hulks. But in some spots where staghorn and other hard corals had bleached white (below), new life blossomed. We saw gardens of baby corals sprouting over fields of bare rock, multicolored sea life mobbing newly lush pastures, and some reefs that had entirely escaped bleaching. Big fish swam all around us—sharks, groupers, mantas, all evidence of a system with a hard-beating heart.

Fiji is like the patient who did *not* die of AIDS, and global reef health may depend on learning why. Support is growing to create protected areas around some of Fiji's reefs, where scientists can hunt for answers. Protection will help ensure that bleaching events won't be compounded by polluted runoff, overfishing, or eager tourists. But in the end, human ability to turn down the heat may ultimately determine either death or renewal.

SWIM WITH THE FISHES Enjoy a video tour of Fiji's underwater world and learn more about its reefs through selected Web links and resources at **nationalgeographic.com/magazine/0411.**



In the shallows of Great Astrolabe Reef, hard corals bloom offshore of Kadavu Island (above). More than 330 islands speckle Fijian waters, which hold nearly 4,000 square miles of reef, a vital trove of marine biodiversity. To safeguard some of these reefs, the Wildlife Conservation Society is working with Fiji to establish a World Heritage Seascape that would help protect the waters between Fiji's two biggest islands.

RED-MARGINED WRASSE *(CIRRHILABRUS RUBRIMARGINATUS)*

SOFT-CORAL COLLAGE

Rising like an inflated pink tree, a soft coral in Somosomo Strait telescopes up with polyps extended to feed on zooplankton borne in by Fiji's exuberant currents (above). A wrasse hovers within its branches, waiting for the same feast. Soft-coral trunks and limbs stiffen with a scaffold of limestone splinters called sclerites. When threatened by rough weather or prying fish, the coral deflates into spiny balls. Many creatures have adapted to live on these soft corals, gleaning dinner and invisibility amid the branches. A pink majid crab

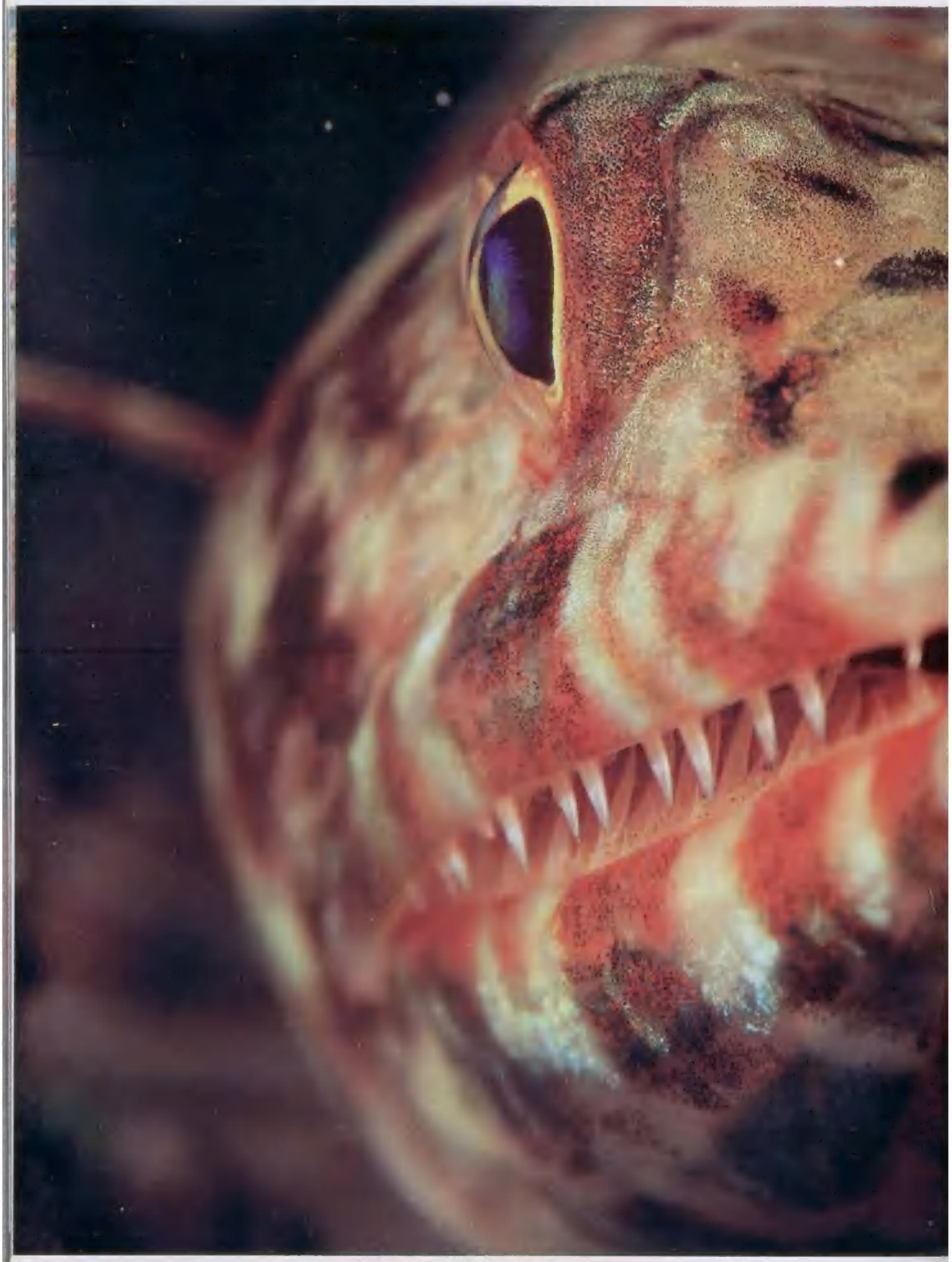
MAJID CRAB *(HOPLOPHRYS OATESII)*

HARLEQUIN GHOST PIPEFISH *(SOLENOSTOMUS PARADOXUS)*

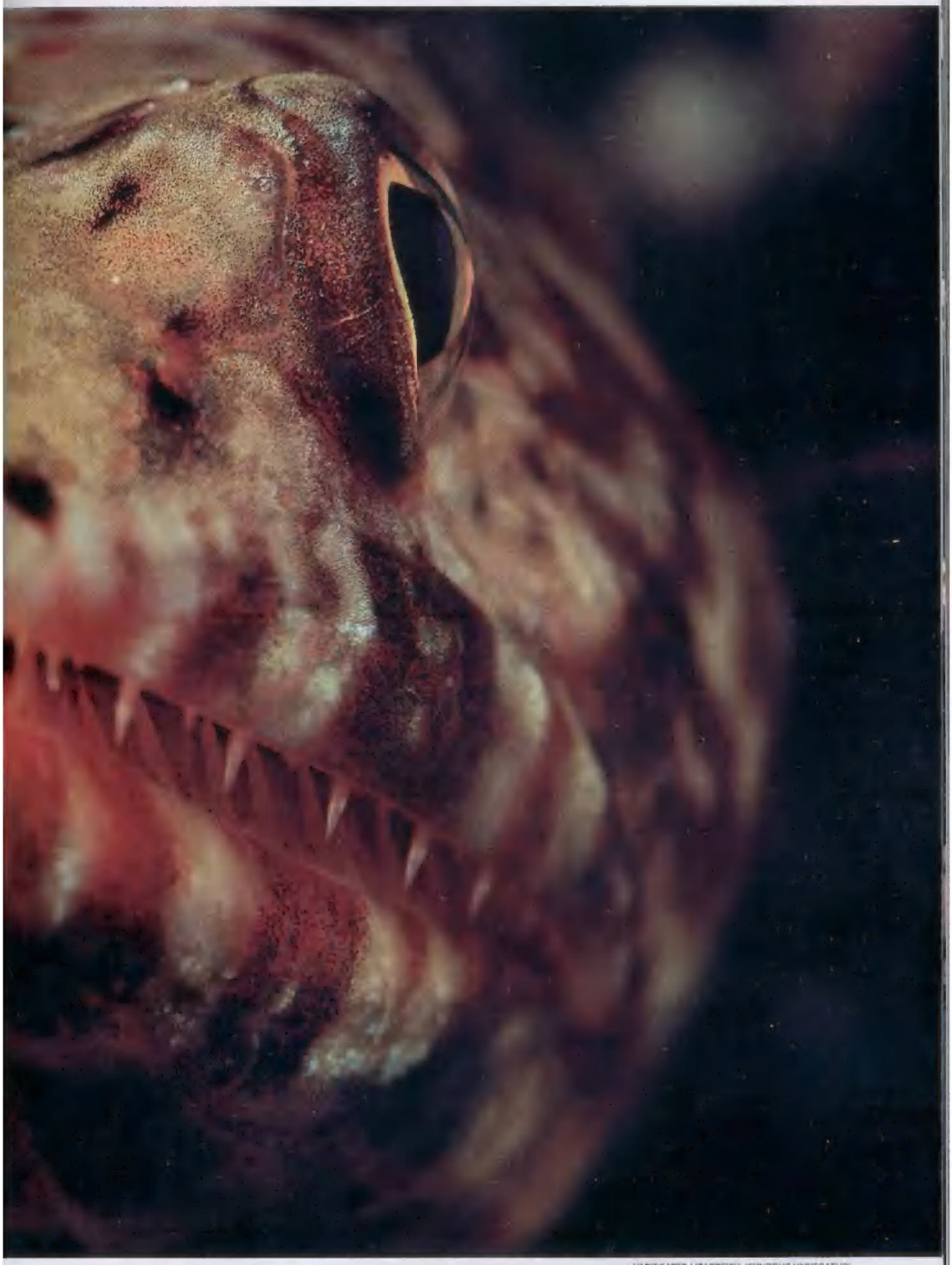
(opposite bottom) and harlequin ghost pipefish (right) nearly vanish on their hosts.

The depths of Vatu-i-Ra reveal scores of fish over a vivid carpet of fluffy soft corals and a bulky hard one mottled with algae (below). Soft Dendronephthya *corals—hallmark of Fijian reefs—do not have symbiotic algae and therefore are not vulnerable to bleaching. Unlike reef-building hard corals that need sunlight in the shallows, soft corals like* Dendronephthya *can live in a range of depths, decorating seawalls and overhangs with improbably vibrant hues.*

ORANGE BASSLETS *(PSEUDANTHIAS SQUAMIPINNIS)*; GOLDEN DAMSELFISH *(AMBLYGLYPHIDODON AUREUS)*



Its face a grimace of grasping teeth, a lizardfish lies in wait for small fish that stray too far from the re



VARIEGATED LIZARDFISH *(SYNODUS VARIEGATUS)*

out a foot long, this ambush predator often hides camouflaged in sand, invisible to prey.

LARGEMOUTH TRIPLEFIN *(LICLA XENOGRAMMUS)*

LAYERS OF LIFE

Minuscule creatures find unlikely safe harbor as denizens of the reef's living skin. Nearly transparent, a triplefin (above) rests on a hard coral's bony face, while two yellow prowling shrimps (below) look almost identical to the wire coral on which they graze and hide. At night a small shrimp, possibly a new species in the family Pontoniinae, feeds on coral mucus, a delicacy for many reef dwellers (opposite top). Hard corals—essentially tiny anemones with a communal skeleton—sting to the touch like larger anemones. Yet legions of tiny fish and shrimps

WIRE CORAL SHRIMP *(PONTONIDES SP. AFF. UNCIGER)*

SHRIMP (FAMILY PONTONIINAE)

have evolved to live with impunity among these coral tentacles, escaping predators' notice by resembling their hosts, a feat called crypsis.

Taking a different tack, a trio of emperor shrimps stand in formation on the deck of their favorite slow ship, a leopard sea cucumber (below). Like dutiful swabbies they eat scum off the skin of their host. Beyond food and limited mobility, the sea cucumber offers defense (when disturbed it will spill its toxic guts out) and a hangout where shrimps can congregate to meet potential mates.

EMPEROR SHRIMPS *(PERICLIMENES IMPERATOR)*; LEOPARD SEA CUCUMBER *(BOHADSCHIA ARGUS)*

With a golden trevally in tow, a massive manta ray wheels majestically through Great Astrolabe Ree

GIANT MANTA *(MANTA BIROSTRIS)*; GOLDEN TREVALLY *(GNATHANODON SPECIOSUS)*

chance to glimpse such giants at close range makes Fiji a magnet for divers and tourists.

BLUE-SPOTTED GROUPER *(CEPHALOPHOLIS MINIATA)*

HUNGER PANGS

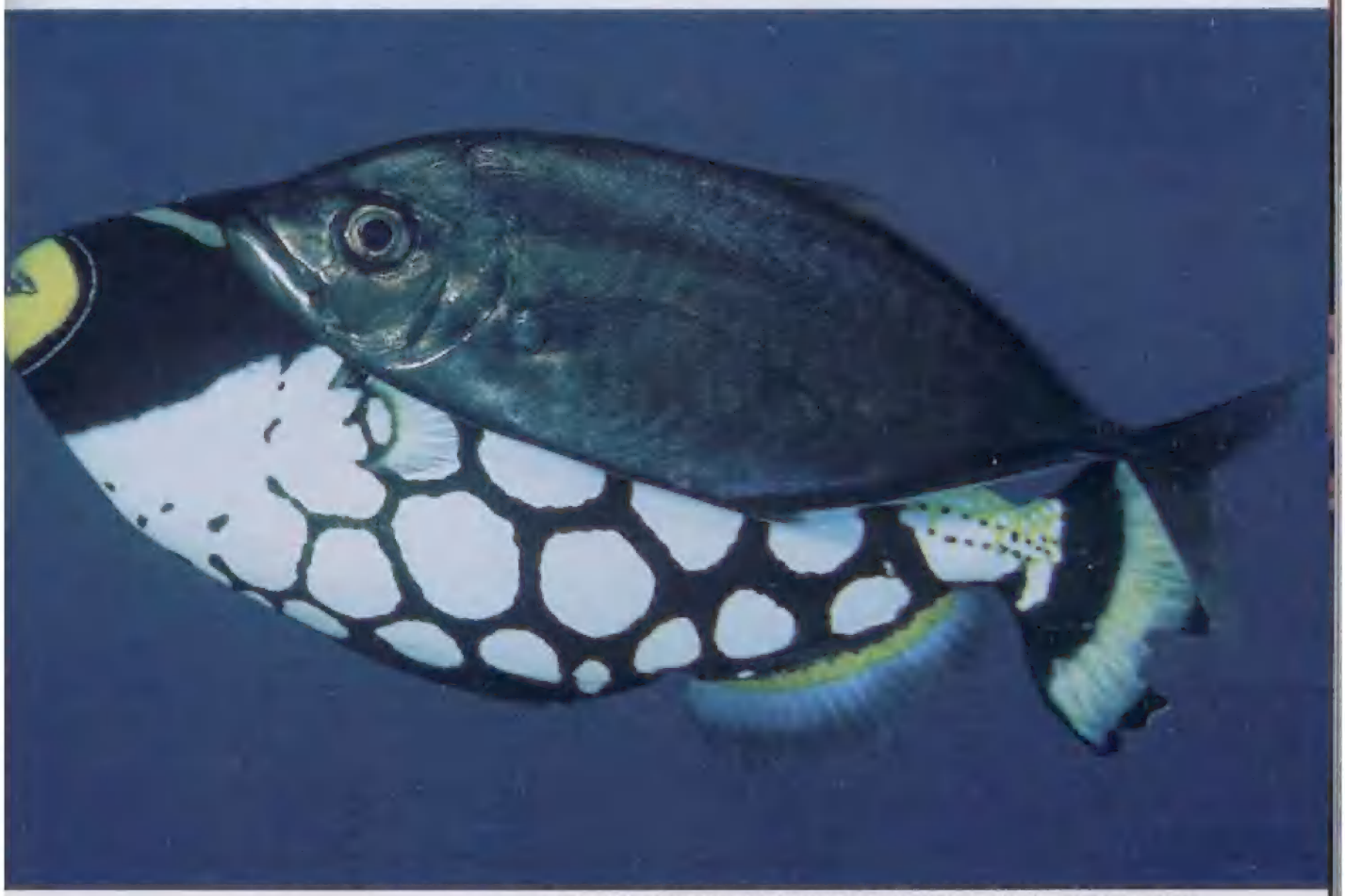
As if frowning with displeasure, a blue-spotted grouper lunges past a human intruder in its hunting grounds. Predation is a constant chore on Fiji's reefs, where extracting food can be hard work in this competitive and heavily armored environment. A parrotfish (below) uses fused tooth plates in its beak and a gristmill in its throat to carve and pulverize reef rock on the hunt for nutrients from algae that coat and bore into coral. (This can keep coral from being suffocated by unchecked algae, but overgrazing can destroy corals.) Long-jawed mackerel

STEEPHEAD PARROTFISH *(CHLORURUS MICRORHINOS)*

LONG-JAWED MACKEREL *(RASTRELLIGER KANAGURTA)*

simply open wide and swim like living colanders (right) to ensnare tiny crustaceans in their expanded gill baskets. A polka-dotted clown triggerfish in search of invertebrates unwittingly conceals a stealthy barcheek trevally that will dart out from its hiding place to snatch unsuspecting prey unafraid of the harmless clown.

Some fish species have colors unique to Fiji. DNA analysis will help us learn whether these are separate species with colors adapted to aid survival—knowledge that could be a key to conservation. □



CLOWN TRIGGERFISH *(BALISTOIDES CONSPICILLUM)*; BARCHEEK TREVALLY *(CARANGOIDES PLAGIOTAENIA)*

AL QAEDA
Global
ACTIVITIES
Funding, planning, and conducting terrorism
MEMBERS
Unknown
Founded by Osama bin Laden in the 1980s, al Qaeda first supported the *mujahidin* fighting Soviets in Afghanistan. Today the group wages war on the world, through a global Islamist insurgency.

NATIONAL LIBERATION ARMY (ELN)
Colombia
ACTIVITIES
Kidnapping, bombing, extortion
MEMBERS *3,000*
This leftist group is one of the leading practitioners of kidnapping for ransom. It also attacks government oil pipelines and energy infrastructure.

REVOLUTIONARY ARMED FORCES OF COLOMBIA (FARC)
Colombia
ACTIVITIES
Bombing, kidnapping, narcotics
MEMBERS
15,000 to 18,000
These communist insurgents use kidnapping and mass murder in their fight to overthrow the Colombian government and redistribute wealth.

UNITED SELF-DEFENSE FORCES OF COLOMBIA
Colombia
ACTIVITIES
Massacres, narcotics
MEMBERS
12,000 to 15,000
This right-wing coalition of paramilitaries was formed to fight leftist insurgents but often targets civilians.

HOT SPOT
COLOMBIA

As communist insurgents battle right-wing militias—and each other—for territory and drug profits, locals are caught in the crossfire. The government is now fighting to regain control of the countryside.

The latest wave of international terrorism has focused the world's attention on a tactic that uses death and destruction as political tools. But terrorism itself, with roots deep in history and geography, is hardly new.

World of

SALAFIST GROUP FOR CALL AND COMBAT
Algeria
ACTIVITIES
Attacks on government and military
MEMBERS
Several hundred
This newly powerful Islamist group aims to topple Algeria's secular government, expel foreign influences, and advance al Qaeda's agenda in Africa and Europe.

MOROCCAN ISLAMIC COMBATANT GROUP
Morocco
ACTIVITIES
Bombing, arms, forgery
MEMBERS
Unknown
This Moroccan Islamist group, reportedly linked to al Qaeda, is accused of recent mass-casualty bombings in Madrid and Casablanca.

BASQUE FATHERLAND AND LIBERTY (ETA)
Spain, France
ACTIVITIES
Assassination, bombing, extortion
MEMBERS
Dozens
Founded in 1959, this group has targeted Spanish officials and security forces in its fight for an independent Basque state in northern Spain and southwestern France.

REAL IRA
Northern Ireland
ACTIVITIES
Assassination, bombing, robbery
MEMBERS
100 to 200
An offshoot that formed after the Irish Republican Army declared a cease-fire in 1997, the RIRA has killed dozens in its fight for a united Ireland, free from British rule.

ULSTER DI... ASSOCIAT...
Northern I...
ACTIVITIES
Bombing, nar... shootings, int...
MEMBERS
Several hund...
Largest of the paramilitary ... favor retainin... rule. Though ... a cease-fire, ... often engage... against Cath...

ISLAMIC RESISTANCE MOVEMENT (HAMAS)
Israel, West Bank, Gaza Strip
ACTIVITIES
Suicide attacks
MEMBERS
Several thousand
Seeking to destroy Israel and extend Muslim rule across the Middle East, Hamas has mounted dozens of suicide attacks against Israeli civilians.

HOT SPOT
ISRAEL & THE OCCUPIED TERRITORIES
Fueled by nationalism and mistrust, the cycle continues: Palestinian insurgents use terrorism against Israeli troops, settlers, and civilians in the occupied territories and Israel—while Israeli forces target militants, often inflicting civilian casualties.

TAWHID W'AL JIHAD
Iraq
ACTIVITIES
Kidnapping, bombing
MEMBERS
Unknown
Jordanian Abu Musab al Zarqawi leads this loose network of jihadists, most of whom are Iraqi. Their common goal: to expel U.S. forces and create a Sunni Islamic state in Iraq. Many of its fighters are veterans of an older group, Ansar al Islam.

PALESTINE ISLAMIC JIHAD
Israel, West Bank, Gaza Strip
ACTIVITIES
Suicide attacks
MEMBERS
Several dozen
Led by operatives based in Lebanon and Syria, this radical group aims to replace Israel with a Palestinian Islamic state.

AL AQSA MARTYRS' BRIGADES
Israel, West Bank, Gaza Strip
ACTIVITIES
Shootings, suicide attacks
MEMBERS
Unknown
This group, linked to Palestinian leader Yasser Arafat's Fatah movement, arose during a Palestinian intifada in 2000.

KACH AND KAHANE CHAI
Israel, West Bank
ACTIVITIES
Shootings, assaults
MEMBERS
Several dozen
Outlawed since the massacre of 29 Muslims at Hebron in 1994, these groups seek to expand Israel by driving Palestinians from the West Bank and Gaza Strip.

HEZBOLLAH
Lebanon
ACTIVITIES
Bombing, hijacking, suicide attacks
MEMBERS
Several hundred
Formed in 1982 after the Israeli invasion of Lebanon, this Iran-backed group claimed victory when Israel pulled out in 2000. Its goal: destruction of the Jewish state.

ASBAT AL ANSAR
Lebanon
ACTIVITIES
Assassinat... bombing
MEMBERS
About 300
These al Qa... extremists ... domestic a... national ta... Lebanon.

WHERE THEY ARE

This map shows a sample of the many groups that use terror to achieve their goals, attracting an array of nationalists, political ideologues, and religious zealots. Some groups are multifaceted, incorporating politics and social programs along with violence; others are purely brutal. Today one type of group—related to a movement called Islamism—has earned an especially high profile for its drive to impose theocracy on Muslim lands and excise "impure" Western influences. According to the CIA, the deadliest of these groups—al Qaeda—operates in 68 countries worldwide.

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KURDISTAN WORKERS' PARTY (PKK)
Turkey
ACTIVITIES
Assassination, bombing
MEMBERS
More than 5,000
Also known as Kongra-Gel, this separatist group operates from northern Iraq and targets Turkish security forces and civilians in its fight for an independent Kurdish state.

HOT SPOT
& PAKISTAN

ar rivals India and Paki-uel over the region of ir, a flash point for con-tween Indian troops kistan-based terrorist . Attacks against the S. government of Paki-re also on the rise.

LASHKAR-E-TAIBA
Pakistan
ACTIVITIES
Massacres, bombing
MEMBERS
Several hundred
With training camps in Afghanistan, LET specializes in daredevil missions with devastating results, directed mainly against Indian troops and civilians in Kashmir.

LASHKAR-E-JHANGVI
Pakistan
ACTIVITIES
Massacres, bombing
MEMBERS
Fewer than a hundred
A small but brutally effective Sunni group, LEJ has attacked Shiite mosques and foreigners in a bid to destabilize Pakistan. Also linked to the 2002 murder of journalist Daniel Pearl.

JAISH-E-MOHAMMED
Pakistan
ACTIVITIES
Massacres, bombing
MEMBERS
Several hundred
This Islamist group is blamed for the bombing of an Indian state legislature in Kashmir that killed 38. Now split into two factions, this group, like others, fights to make predominantly Muslim Kashmir part of Pakistan.

LIBERATION TIGERS OF TAMIL EELAM
Sri Lanka
ACTIVITIES
Assassination, bombing
MEMBERS
10,000 to 15,000
Favoring suicide attacks, members seek an independent Tamil state in Sri Lanka. A precarious cease-fire is now in place.

PINES

HOT SPOT
INDONESIA & PHILIPPINES

Recent acts of terrorism have claimed hundreds of lives in Indonesia, prime target for indigenous groups like Jemaah Islamiyah that are now affiliated with al Qaeda. In the Philippines, Muslim and Marxist rebels are an ongoing threat to stability.

ABU SAYYAF
Philippines
ACTIVITIES
Kidnapping, bombing, piracy
MEMBERS
300 to 500
High-profile kidnappings of foreigners for ransom keep this group well financed—though the profit motive may be clouding Abu Sayyaf's founding vision of an Islamic state in the southern Philippines.

MORO ISLAMIC LIBERATION FRONT
Philippines
ACTIVITIES
Bombing
MEMBERS
Around 12,000
Though it officially disavows terrorism, this insurgent group is linked to attacks on Philippine cities through its support for Jemaah Islamiyah. Now in peace talks with the government, the MILF aims for ethnic autonomy.

JEMAAH ISLAMIYAH
Southeast Asia
ACTIVITIES
Bombing
MEMBERS
Unknown
Responsible for a series of deadly bombings across Southeast Asia —including the Bali nightclub attacks in 2002— al Qaeda's local partner seeks an Islamic superstate spanning the region.

ISLAMIC MOVEMENT OF UZBEKISTAN
Central Asia
ACTIVITIES
Bombing, kidnapping
MEMBERS
More than 1,000
This homegrown Islamist coalition seeks to replace Uzbekistan's secular regime and advance the regional goals of al Qaeda.

CHECHEN SEPARATISTS
Russia
ACTIVITIES
Bombing, kidnapping, murder
MEMBERS
Several thousand
Seeking independence from Russia, rebels have killed Moscow-backed Chechen officials, including Chechnya's president, and killed and kidnapped Russian civilians.

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both
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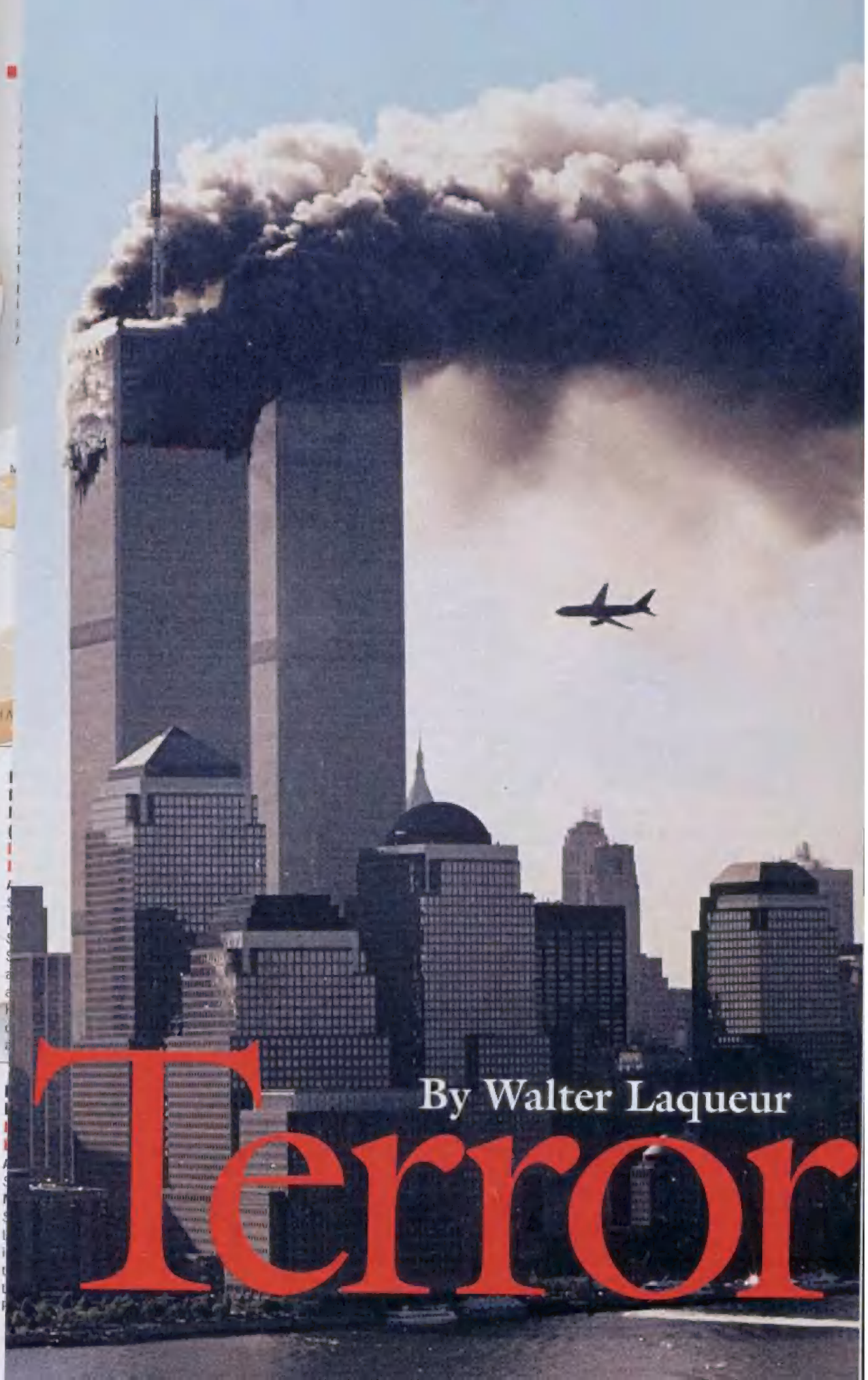
within

Countries where al Qaeda cells are known to be operating

Countries where al Qaeda cells may be operating

Group affiliated with al Qaeda

NATIONAL GEOGRAPHIC MAPS



By Walter Laqueur

Terror

As the new century began, an epidemic of terrorism spread panic around the globe. In world capitals, leaders fortified their security and curtailed public appearances. Ordinary citizens felt unsafe walking the streets of major cities, while the terrorists themselves were like phantoms—everywhere and nowhere at the same time, seemingly able to strike at will. Terrorism became the preoccupation of police and politicians, bankers and business leaders. Headlines screamed out news of the latest outrage: "WASHINGTON STUNNED BY THE TRAGEDY" in one paper, "IN GREAT PERIL" in another. One horrific September terrorist attack, in the United States, sent the stock market reeling and sparked anti-immigrant sentiment. Another attack, in Madrid, plunged Spanish politics into turmoil over issues of war and peace. Politicians in the U.S. took to describing the war on terror as a struggle of good versus evil, while some religious leaders, quoting scripture, proclaimed that the end of the world was at hand.

The year was 1901.

As frightening as modern terrorism is, the bitter fear it generates would have been familiar to those alive at the turn of the 20th century. A few decades before, Russian revolutionaries had killed Tsar Alexander II with a bomb in St. Petersburg. In 1894 an Italian anarchist stabbed French president Sadi Carnot. In 1897 the Spanish prime minister was assassinated just as Cuba's drive for independence was boiling over; within a year, Spain was at war with the United States. And in 1901 William McKinley, President of the U.S., was assassinated by a 28-year-old anarchist, Leon Czolgosz. Thirteen years later, of course, a Serbian terrorist shot and killed Archduke Ferdinand, heir to the throne of Austria—and triggered World War I.

Obviously terrorism—defined here as the systematic use of murder, injury, and destruction, or the threat of such acts, aimed at achieving political ends—has the power to alter the course of history, as the 9/11 attacks in New York and Washington, last spring's train bombings in Madrid, and bloodcurdling headlines from Israel and Iraq remind us today. And with the additional threat posed by weapons of mass destruction, it does seem that humanity has crossed into a perilous new

Walter Laqueur, one of the world's leading experts on terrorism and guerrilla warfare, recently retired from the Kissinger Chair at the Center for Strategic and International Studies in Washington, D.C. His latest book is *Voices of Terror* (2004).

HISTORY OF TERROR

The word "terrorism" has no universally accepted definition, but it has been applied to tactics serving a variety of causes—ranging from the purely personal to struggles for independence or freedom from oppression. Through history there have been few common threads beyond a willingness to use violence for political ends. In the 21st century the violence has reached previously unseen levels.

FIRST CENTURY

Dagger Men

The hard core of Jewish Zealots were called Sicarii, from the Latin word for dagger. These militants opposed the Roman rule of Judaea in the years preceding the leveling of the Jewish Temple and the destruction of Jerusalem in A.D. 70. Among other violent acts designed to spur the popular war of independence that began in A.D. 66, they murdered Roman officials and high-ranking Jews they considered enemies of the fight to liberate the Jewish people from Rome.

11th CENTURY

The Assassins

Murdering prominent enemies was a religious duty to this Islamic sect. From its strongholds in Syria and present-day Iran, the group terrorized the Middle East, where they were called *hash-shashin* by their Arab enemies for their rumored use of hashish. Though modern-day scholars question this charge, a variant of their name—assassin—entered the vernacular and is now applied to those who murder royals, presidents, and other officials.

1773

Terror and Tea

The dumping of tea into Boston Harbor by colonists in American Indian costumes to protest British tax policy is a celebrated event in American history. But if it were repeated today, the Boston Tea Party would fall within the FBI's definition of terrorism, which includes property destruction as a means of political coercion.

PRECEDING PAGES: (OSAMA BIN LADEN), CORBIS/SYGMA. LEFT: MASATOMO KURIYA, CORBIS. BOTTOM ROW, FROM LEFT: BETTMANN/CORBIS; HULTON-DEUTSCH COLLECTION/CORBIS; BETTMANN/CORBIS

era, in which a new breed of terrorist, armed with fearsome new weapons, has acquired the means to challenge even the most powerful nations on Earth.

How did the world come to this point? What in the world has changed?

Terrorism is as old as the story of mankind. It appears in the history of ancient Greece and Rome—the murder of Julius Caesar was an act of terror—and in practically every century since then, and in every part of the world. But much has changed in just the past century, starting with the choice of targets. In the past the typical victim of terrorism was an emperor or a king, a president, a general, or at least a government official. Terrorists would actually call off an attack in order to spare innocent lives, because indiscriminate killing was considered both immoral and politically unwise. Many of today's terrorists feel no such inhibitions.

Motives have also changed. A century ago terrorism was mainly used by groups and individuals whose aims were either revolutionary or anarchist or, in the case of Ireland and the Balkans, nationalist. A look at the geography of terror around 1970 still showed the same basic trends—left-wing terrorism in Europe and Latin America; nationalist or separatist terrorism in Northern Ireland, Spain's Basque region, and the Middle East; and a few right-wing terrorist groups in Italy, Turkey, and other countries.

Today, however, extreme Islamist groups such

MOSCOW A bus moved survivors after Chechen rebels seized some 800 theatergoers in 2002; 129 hostages died.

BALI Al Qaeda–linked Islamists set off bombs at crowded nightclubs in 2002, killing 202 people.

1881

Death of a Tsar

Radicals in Russia assassinated Tsar Alexander II after failing to start a peasant uprising in opposition to the monarchy. Soon after, the government eliminated the group responsible—Narodnaya Volya, or People's Will—amid widespread antirevolutionary sentiment. But Russia had not seen the end of revolutionary terror.

1914

Balkan Bloodshed

Some of the national groups encompassed by the Austro-Hungarian Empire resented their subservience to the Austrian monarchy. When a radical Serbian nationalist shot Archduke Ferdinand of Austria, heir to the throne, and his wife as they toured the Balkans, it provided the spark that ignited World War I.

ISTANBUL Suicide bombers attacked British and Jewish targets in 2003; Britain's consul general was among 58 dead.

ABOVE, FROM TOP: REUTERS/CORBIS; PER WILKUND, CORBIS; LYNSEY ADDARIO, CORBIS

WHAT THEY'VE DONE

Terrorism's recent death toll—measured in thousands—is dwarfed by the numbers of dead from war, genocide, and famine. But with mass slaughter and apocalyptic weapons now on the terrorist agenda, the scale of the threat is rising. A look at selected attacks over the past decade may suggest what lies ahead.

NORTH AMERICA
The continent was relatively free of terrorism until the mid-1990s. Since then both Islamist and homegrown anti-government terrorism has resulted in thousands of deaths.

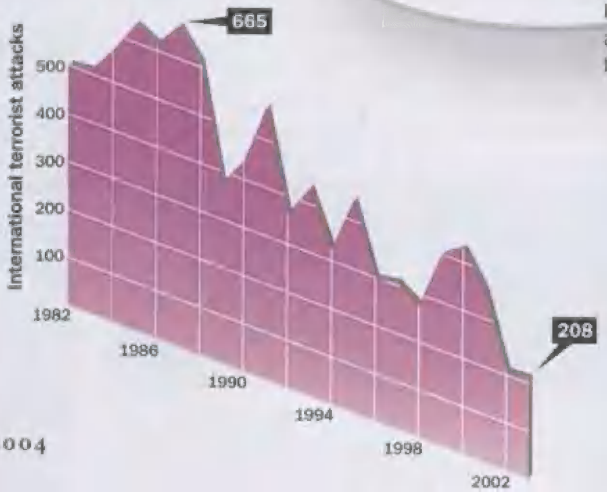
LATIN AMERICA
Terror is a fixture of civil conflict in Colombia and elsewhere. Bombs and kidnapping are popular political tools, but death totals are relatively low.

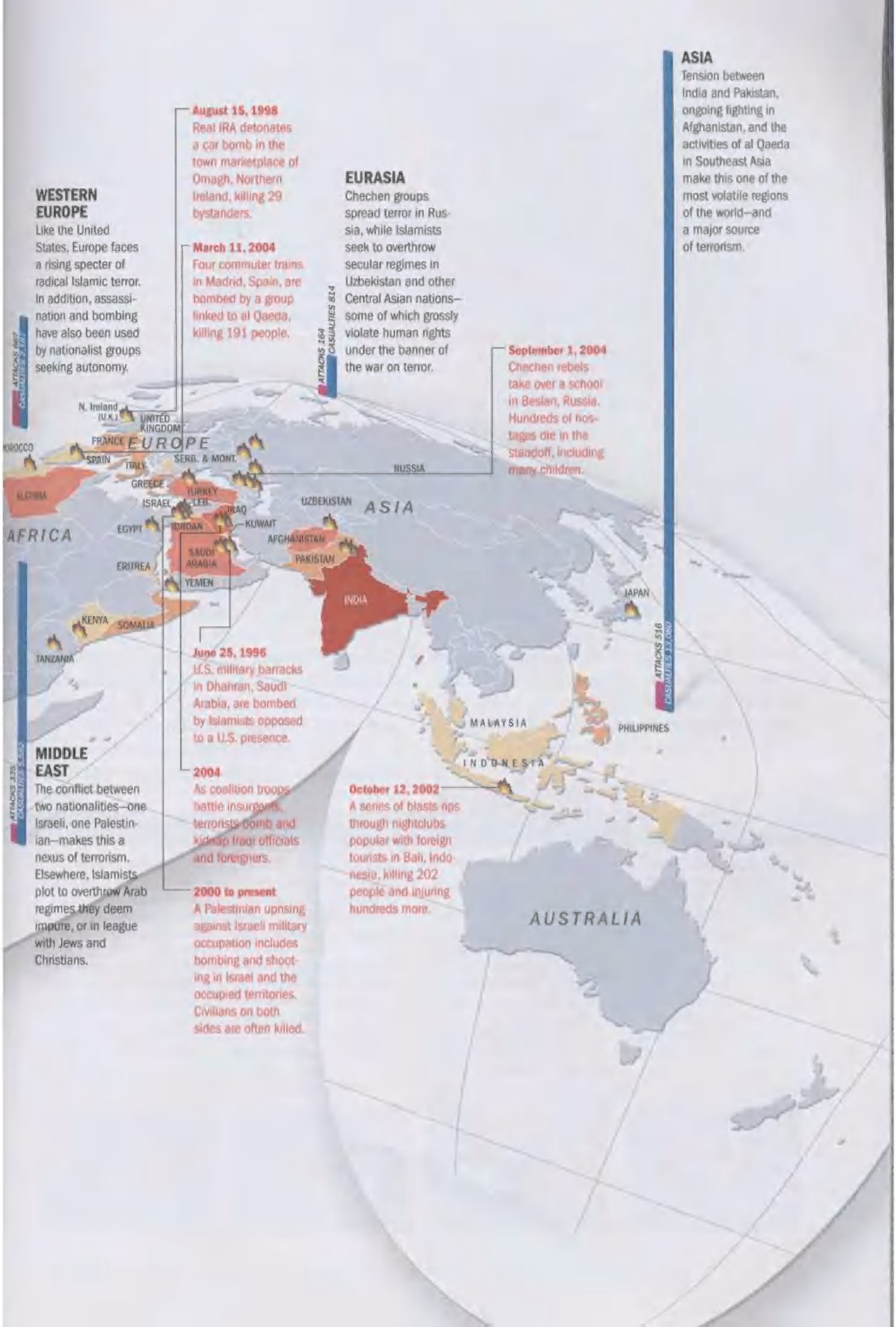
AFRICA
Terror is often part of conflicts on the continent. Chronic political instability raises fears that—like Afghanistan after its civil war—parts of Africa may become a haven and recruiting ground for al Qaeda.

SOURCE: U.S. DEPARTMENT OF STATE
NATIONAL GEOGRAPHIC MAPS

TRENDS IN TERROR

Terrorist acts have decreased over the past 20 years, but the carnage has increased. The trend, says the U.S. State Department, is "toward more ruthless attacks on mass civilian targets."




WESTERN EUROPE
Like the United States, Europe faces a rising specter of radical Islamic terror. In addition, assassination and bombing have also been used by nationalist groups seeking autonomy.
ATTACKS 867
CASUALTIES 2,218
August 15, 1998
Real IRA detonates a car bomb in the town marketplace of Omagh, Northern Ireland, killing 29 bystanders.
March 11, 2004
Four commuter trains in Madrid, Spain, are bombed by a group linked to al Qaeda, killing 191 people.
EURASIA
Chechen groups spread terror in Russia, while Islamists seek to overthrow secular regimes in Uzbekistan and other Central Asian nations–some of which grossly violate human rights under the banner of the war on terror.
ATTACKS 164
CASUALTIES 814
September 1, 2004
Chechen rebels take over a school in Beslan, Russia. Hundreds of hostages die in the standoff, including many children.
ASIA
Tension between India and Pakistan, ongoing fighting in Afghanistan, and the activities of al Qaeda in Southeast Asia make this one of the most volatile regions of the world–and a major source of terrorism.
ATTACKS 516
CASUALTIES 3,700
October 12, 2002
A series of blasts rips through nightclubs popular with foreign tourists in Bali, Indonesia, killing 202 people and injuring hundreds more.
MIDDLE EAST
The conflict between two nationalities–one Israeli, one Palestinian–makes this a nexus of terrorism. Elsewhere, Islamists plot to overthrow Arab regimes they deem impure, or in league with Jews and Christians.
ATTACKS 375
CASUALTIES 5,500
June 25, 1996
U.S. military barracks in Dhahran, Saudi Arabia, are bombed by Islamists opposed to a U.S. presence.
2004
As coalition troops battle insurgents, terrorists bomb and kidnap Iraqi officials and foreigners.
2000 to present
A Palestinian upsing against Israeli military occupation includes bombing and shooting in Israel and the occupied territories. Civilians on both sides are often killed.
N. Ireland (U.K.)
UNITED KINGDOM
FRANCE
EUROPE
SPAIN
ITALY
SERB. & MONT.
GREECE
TURKEY
RUSSIA
ALGERIA
ISRAEL
LEB.
IRAQ
KUWAIT
UZBEKISTAN
ASIA
AFRICA
EGYPT
JORDAN
AFGHANISTAN
SAUDI ARABIA
PAKISTAN
ERITREA
YEMEN
INDIA
JAPAN
KENYA
SOMALIA
TANZANIA
MALAYSIA
PHILIPPINES
INDONESIA
AUSTRALIA

as al Qaeda have moved to the vanguard of global terrorism. According to the CIA, al Qaeda or affiliated groups are operating in 68 countries worldwide. And while the 9/11 attacks in New York and Washington represent their most spectacular success to date, other attacks have occurred in Morocco, Tunisia, Spain, Indonesia, the Philippines, Turkey, Saudi Arabia, Afghanistan, Chechnya, Iraq, and Russia—all since 9/11. According to Osama bin Laden and other leaders, al Qaeda is motivated by the Islamic tradition of jihad, or holy war, to defend the faith against nonbelievers. They see themselves as engaged in a global struggle against a corrupt and oppressive enemy, the West.

Compare this with the motives of the Russian anarchists of 1881, or the Oklahoma City bombers, or Peru's Shining Path, or the Irish Republican Army, or the Unabomber. Obviously, terrorists have very little in common ideologically. What they share is willingness to use the same brutal tactics to achieve their goals.

They also are not, despite a popular misconception, driven to terrorism by personal poverty. The leaders and many of the foot soldiers in the Islamist movements come from solidly middle-class backgrounds, and some, like bin Laden, from very wealthy families. That's not to say that social factors like poverty and despair don't radicalize populations. But hunger by itself does not necessarily lead to political violence; many of the world's poorest nations report little or no terrorism.

Nor is it true that terrorism occurs in the most repressive regimes. There was little terrorism in Nazi Germany, Stalinist Russia, or Saddam Hussein's Iraq. Terrorism needs a certain amount of freedom to mobilize its supporters and to get organized; it suffocates in a dictatorship, which itself practices a form of terrorism, but wearing uniforms and insignia.

Hundreds of national and religious minorities in the world are persecuted; there are few nations, in fact, in which minorities do not feel oppressed. But only a handful resort to terrorism, and here cultural and social traditions seem to play a role. Certain human societies seem to tolerate violence more readily than others. Why did the radical Basques in Spain choose terrorism while the Catalans followed a more peaceful path? Why did the Tamil Tigers in Sri Lanka engage in one of the longest and bloodiest terrorist campaigns in history, while the Muslims of Sri Lanka, also repressed, did not?

Terrorism also seems to require charismatic leaders capable of inspiring recruits to face danger or death, and also to win the sympathy of the surrounding population. In post–World War II Palestine, the Zionist terrorist groups Irgun and Stern Gang enjoyed support from parts of the Jewish community in Palestine and the U.S. and helped in driving out the British; an Irgun commander, Menachem Begin, was

HISTORY OF TERROR

1963

Hate Breeds Terror

Southern racists, including Ku Klux Klan members, reacted violently to the civil rights movement in Birmingham, Alabama, carrying out a bombing campaign that would earn the city the nickname "Bombingham." There a KKK bomb killed four young girls attending Sunday school at the 16th Street Baptist Church.

1972

Deadly Games

In a tragedy that played out on worldwide television, members of a Palestinian terror group killed two and seized nine Israeli athletes at the Munich Olympics. German police failed in attempts to free the hostages, and all nine were murdered. Israeli commandos later tracked down and killed most of the surviving hostage takers.

1983

Murder by Suicide

Sixty-three people died in an attack on the U.S. Embassy in Beirut by the Lebanese group Hezbollah —the first time a suicide attack caused mass casualties in the Arab-Israeli conflict. Later that year, more than 240 U.S. Marines died in another suicide bombing. President Ronald Reagan reacted by withdrawing U.S. troops.

1995

American Made

The U.S. was focused more on foreign terrorism than the homegrown kind—until decorated veteran Timothy McVeigh set off a truckload of ammonium nitrate fertilizer in front of Oklahoma City's federal building, killing 168 people, including 19 children. The attack drew attention to radical antigovernment rightists. McVeigh was executed in 2001.

BOTTOM ROW, FROM LEFT: HULTON-DEUTSCH COLLECTION/CORBIS; GETTY IMAGES; AP/WIDE WORLD PHOTOS; WIN MCNAMEE, REUTERS; YOMIURI SHIBUN, CORBIS/SYGMA; AL JAZEERA VIA REUTERS TV, REUTERS/CORBIS. OPPOSITE TOP: KAI PFAFFENBACH, REUTERS/CORBIS

SPAIN Bombs at rush hour killed 191 people in Madrid in March of this year. Authorities blamed al Qaeda associates.

later elected prime minister of Israel. Conversely, leaders of the Japanese group Aum Shinrikyo, which attacked the Tokyo subway with poison gas in 1995, had little support beyond their ranks—and today they languish in jail.

What can be done to counter, or at least to defuse, the danger of terrorism in the future? Some movements are open to political solutions—especially those demanding greater political autonomy, such as the Kurds in Turkey and the Chechens in Russia. But the more radical groups like al Qaeda are not interested in compromises; they demand total victory.

In the long term, such white-hot fanaticism may burn out and even disappear, making way for new kinds of zealotry. But in the meantime, we are faced with one of the most dangerous passages in human history. For the first time ever, terrorists—these small and unpredictable groups of people, stateless, tethered to no morality other than their own—have a potential for harm that defies the imagination, should weapons of mass destruction fall into their hands. Civilization will prevail—it always has—but there can be no final victory in the "war on terror," which, in one form or another, will continue as long as there are conflicts on Earth. □

1995	2004
Subway Apocalypse Members of the Japanese religious cult Aum Shinrikyo thought the end of the world was at hand, and they intended to help it along by releasing the deadly nerve gas sarin into the Tokyo subway system at rush hour. The attack, which killed 12 people and sickened thousands, pointed out the vulnerability of modern transportation systems.	**Worldwide War** Insurgents in Iraq threatened to behead South Korean hostage Kim Sun-il unless his government withdrew its troops from the embattled country. It refused, and Sun-il was executed. Such brutal tactics test the resolve of nations waging a global war on terror that has strained international alliances and fueled anti-U.S. sentiment.

WHO'S WINNING THE WAR ON TERROR? Is one person's terrorist another's freedom fighter? Can terrorism be defeated? Share your opinion in our Forum, and access a list of related websites at **nationalgeographic.com/magazine/0411.**

NATIONAL GEOGRAPHIC RESEARCH AND EXPLORATION

RESEARCH SCHOLAR
K. Yoganand
Wildlife Institute of India

"Sloth bears have to compete with charismatic species such as tigers. The bears get far less attention than they deserve."

Nose to Nose with Sloth Bears

The front end of a sloth bear is unmistakable. From its shaggy black head protrudes a long whitish muzzle. The three-inch-long front claws are ivory white. These are the tools of this specialized bear's trade: feeding on termites and ants by ripping up their mounds and nests. The species has been studied for almost ten years by Indian researcher K. Yoganand—"Yogi" to his friends.

By John L. Eliot
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by K. Yoganand

Scientific blunders can live on forever. When 18th-century European museum curators were first sent specimens of a large furry mammal with long curved white claws, they named it "bear-like sloth" because its claws resemble those of South American sloths. Later taxonomists realized that the species was a tropical bear unrelated to sloths, but its wrongheaded name remains—the sloth bear.

Ranging India, Nepal, Bhutan, Sri Lanka, and possibly Bangladesh, these 150- to 300-pound bears feed on fruits and insects. They sound like bellows when using their flexible snouts and lips to blow away dirt and suck up termites and ants. But don't be misled: This frowsy, gentle-looking bear can be ferocious, occasionally mauling or killing villagers who enter the forest. Yoganand often talks with villagers to help minimize conflicts. "Attacks can be prevented if people avoid certain places."

THE PROJECT

STUDY SITE: Panna National Park, India
GRANTEES: Cliff Rice and K. Yoganand
KEY AIMS: To study behavior and habitat needs of sloth bears, investigate causes of conflicts with people, develop methods for estimating and monitoring India's sloth bears
POPULATION: An estimated 6,000 to 11,000 sloth bears live in India.

Climbing aboard their mother (right), cubs prepare to ride "bearback." This radio-collared female will give her cubs a free lift until they're about six months old, a behavior unique among bear species. Carrying her cubs may help the female defend them from tigers, leopards, and hyenas.

"I climbed out on a tree growing from a ledge to get this rare picture," says Yoganand of two cubs nursing from their mother (left). A nearby cave served as their den. Cubs are often abducted by poachers and sold to itinerant Qalandar people, who train sloth bears to "dance" in their roadside shows (above). Animal welfare groups are working to convince the Qalandars to give up their bears—an estimated thousand throughout India.

One goal of his research has been to track the roamings of a dozen radio-collared bears in the dry deciduous forests of India's Panna National Park. He's discovered that some bears have home ranges of up to 40 square miles. His conclusion: "We need to protect large patches of their habitat and maintain links between those patches. Unfortunately sloth bears have to compete with charismatic species such as tigers. The bears get far less attention than they deserve." □

NO TEDDY BEAR Some villagers in India fear sloth bears more than tigers. Find out why in Resources at **nationalgeographic.com/magazine/0411.**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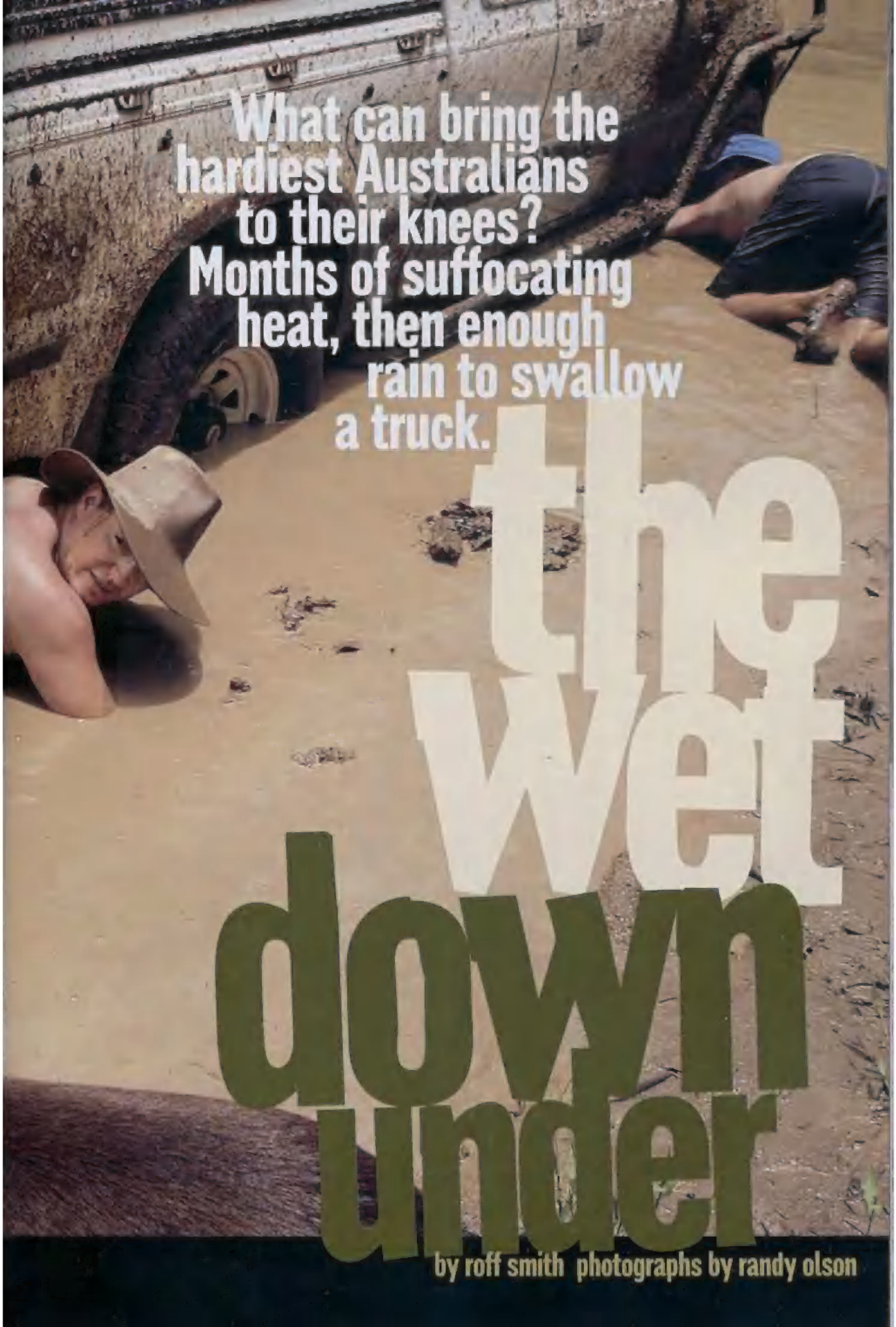


What can bring the hardiest Australians to their knees? Months of suffocating heat, then enough rain to swallow a truck.

the wet down under

by roff smith photographs by randy olson

Like a frayed whip, lightning cracks over Kakadu National Park while rain falls in the distance. From October to December, the mostly dry buildup to the monsoon season Australians call the wet, temperatures can soar past 100°F as humidity bastes locals in sweat. So they sit and stew, dreaming of a cool downpour.

Feeling is believing for five-year-old Tobi Conner, who reaches out for the first rain in Broome this year. The wet's high-water month, usually January or February, dumps up to 30 inches of rain on Australia's tropical north. During the depths of the dry—June and July—it hardly rains at all.

Waiting out the Wet

or . . .

. . . how Aussies make it through the monsoon without going completely bonkers

THE CAST Mick and Kerriann Jones and various others
STAGEHAND Roff Smith

ACT ONE The Buildup
Scene One The Animal Bar, Karumba • *Scene Two* Yappar Street
Scene Three Yappar Street, a Week Later • *Scene Four* Going Bush
Scene Five Back in Town

ACT TWO The Wet
Scene One Yappar Street • *Scene Two* At Sea • *Scene Three* Far North

ACT THREE The Dry
Scene One Karumba

ACT ONE

The Buildup

Scene One

The Animal Bar, Karumba

Everybody comes to the Animal Bar. It's the popular nightspot in Karumba, a raffish old port on the Gulf of Carpentaria in outback Queensland's far northwest. And never is it livelier than on a hot, thundery Friday night such as this, with the monsoon building, the fleet back in town, and the cash prize in the pub's weekly "lucky dip" jackpotting to nearly $5,000. By eight o'clock, when I rolled up, the notorious old watering hole was just hitting its stride, a row of hard-bitten four-wheel drives angle-parked out front and, under the roof, a welcoming swirl of noise and smoke, bare feet and tattoos, brassy laughter, clinking bottles, and the occasional sharp crack of a cue ball.

I ordered a bottle of XXXX, or as the joke around here goes: How Queenslanders spell "beer." The barmaid handed me some colored paper chits with my change, tickets for the night's big draw. As I stepped away from the bar, an old friend of mine, Mick Jones, the police sergeant in town, sidled up beside me with a few words on local etiquette: "If you win, mate," he said, "remember, there's no way they're going to let anyone run out of here with five grand in their pockets and not buy drinks. So just be sure you say, 'basics only'—that's wine and beer—because if you don't,

Eyes of the storm: As manager of Marrakai Station, a 220-square-mile spread near Darwin, Leonard Baker used four-wheel bikes, helicopters, and airboats to muster 8,000 cattle and buffalo to higher, drier ground before the wet. Once it sets in, most cattlemen hunker down and hope their fences don't wash away.

there's blokes here who'll start ordering doubles and triples of some very fancy drinks, and you won't be left with a brass razoo." I stole a swift look around at the eager, sunburned faces of the Animal Bar's cast of regulars and thanked him for the advice.

As things turned out, I didn't have to shout any rounds of drinks that night. Nobody did. The jackpot didn't go off for a few more weeks. When it finally did, it was won by a woman who had the ready wit and good nature to announce —and get away with it—that instead of buying drinks for the house, she'd be making a thousand-dollar contribution toward the town's Christmas pageant. "What a brilliant idea," Mick exclaimed that night. "Wish I'd thought of it."

By then I'd come to know the faces in the crowd so much better—"Fatty" Daniel, the heavily muscled captain of the M.V. *Wunma*, the vessel that ships out zinc, lead, and silver ore from the Zinifex Century Mine about 170 miles to the southwest; Alan Lourie, the skipper of the *Karinya II*, the supply barge that does the weekly run out to Mornington Island; Brendan Carter, who runs the prawn factory; Bruce Davey, a colorful third-generation mackerel and barramundi fisherman and skipper of the fishing vessel *Wildcard*. And by then I'd come to understand that they—and I, and Mick, and all of us up there—were walk-on characters, bit players, in the great traveling show that barnstorms Australia's wild tropical north this time every year: the coming of the monsoon, better known as the wet.

It's a three-act drama that opens each spring, late in September, when the complex climatological machinery that drives the monsoon changes gear and begins to draw the rainy-season weather down from India. Clouds appear over the Timor and Arafura Seas. Temperatures soar, tempers fray in the humidity, and thunder

grumbles in the haze, like meteorological throat-clearing for the tongue-lashing to come. It's the time of year locals call the buildup, the steamy tension-building prelude to the second act—an explosive Wagnerian crescendo of angry purple skies, jagged bolts of lightning, kettledrum thunder, and downpours culminating in what some northern Aborigines know as *banggerreng*, the "knock 'em down rains." This is the wet itself, which can start anytime from the first week of December and generally lasts through March. Outback rivers that have been dry for months suddenly become raging cataracts, vast areas are flooded, and washed-out roads mean that towns such as Karumba can be cut off for weeks, sometimes even months. Then, usually in April, with the skies clearing and the once harsh outback landscapes revealed as flowering wetlands, it's back to dry times again, the third and final act.

The script is never the same two seasons in a row, and the story never loses its impact or appeal: The wet, with its transforming rains and spectacular electrical storms, is the defining event of the year to those who live above the Tropic of Capricorn, while it tugs at the imaginations of those of us (and that's most Australians) who live below it.

For a long time one of my favorite escapist fantasies had been to sit through the wet in some remote tropical town—just to see what it would be like. So when Mick Jones invited me to come up to Karumba and do just that, thoughtfully offering me the independence of the old bunkhouse at the police barracks, I jumped at the chance. In my mind's eye, I was already picturing hard tropical rains coming down like a beaded glass curtain, sizzling on the pavement of the town's main street and making the palm fronds glisten. The rains hadn't yet arrived when I drove into town early in November, but the heat lightning pulsing in the skies that first night at the Animal Bar seemed the perfect curtain-raiser.

Scene Two

Yappar Street

Roosters were crowing in backyard gardens all along Yappar Street—Karumba's main thoroughfare—when I set out in the predawn dimness for my morning stroll around the town, a much looked-forward-to part of my daily routine the past few weeks. It was early December, six o'clock—the "cool" of the day—and already a feverish 80-odd degrees. I caught sight of Mick and his wife, Kerriann, on their usual four-mile jog to the edge of town and back—way too vigorous for my cool-climate blood. But then Mick was born in Papua New Guinea, grew up in the tropics in an old Queensland fishing family, and has spent his 15-year police career in the bush, and Kerriann was raised here in Karumba. To them the temperature was fresh and inviting.

Karumba, which has about 500 people, is nestled among the seasonal marshes, tidal flats, and crocodiles at the mouth of the Norman River, the only town along hundreds of miles of a ragged, mangrove-fringed coast virtually unchanged since the Dutch explorer Abel Tasman sailed along it in 1644. It's a fishing town: tiger prawns, banana prawns, and barramundi. A few large blue-and-white prawn boats are tied up on the riverfront, while a handful of scruffy old sloops and trawlers lie at anchor along the mangroves on the opposite bank. Mick and Kerriann live with their two little girls, Jessica and Kacie, in a high-set house behind Karumba's two-man police station, with a shaggy old mango tree in the backyard and a broad, flowering poinciana shading the front. He walks about 15 paces to work.

In most places these days a town of 500 would have just a pub and a post office, a little shop if it was lucky, but Karumba has two pubs, a bakery, druggist, café, marine repair yard and fuel depot, and two cold-storage warehouses. Out here there's no other place to go, no larger town nearby to rob it of business; the nearest neighbor is Normanton, population 1,500, 40 miles away across the flats. After that it's nearly a hundred miles to a sleepy little place called Croydon, and then another achingly empty 90 miles to Georgetown—and so on, a scattering of outback villages along a thin ribbon of bitumen stretching nearly 500 miles to Cairns and the coast. A notice tacked on Karumba's community bulletin board outside the grocery store gives the dates when a traveling dentist will be passing through, while a sign on the sidewalk announces that a traveling hairdresser will be in town this coming weekend, setting up shop for two days only in the back room at the café.

I sauntered across the street and down to the slipway on the river, where the old Empire flying boats used to dock and refuel back in the seat-of-the-pants days of aviation in the 1930s, when flights between Sydney and Britain took nine days.

I liked to sit at the old picnic table there, watch those huge monsoonal clouds glowing pink and gold in the sunrise and speculate about whether this day might finally, at long last, see rain.

But it never seemed to. And today wasn't shaping up any differently—clouds towering 40,000 feet above the savanna but with an aloof look to them, and a feel in the air that I was beginning to recognize like a local: no rain today. Not here, at least. I found myself thinking about that droll bit of dialogue from *Casablanca,* where Bogart tells Claude Rains that he came to Casablanca for the waters. "The waters? What waters?" asks the bemused Rains. "We're in the desert." To which Bogie replies, with his trademark irony: "I was misinformed."

I was feeling that way myself. So far I had idled here for weeks in sweltering heat without a drop of rain falling, only blazing tropical sunshine and not much in the forecast but more of the same. Sometimes there wasn't a cloud in the sky—just those arid southeasterlies blowing up from the deserts, dry-season weather that rattled the palm fronds along dusty old Yappar Street and frayed tempers in a town that had been waiting on the rains now for eight months. Drive to the edge of town and look all around. You'd see nothing but heat waves shimmering to the horizon.

The waters? What waters? We're in the desert.

I sat by the old flying-boat ramp watching the clouds boil up over the savanna until the sun started to bite too hard. I walked back up Yappar Street in blinding glare, suffocating heat already radiating up from the bitumen. It was going to be another stinker.

Scene Three

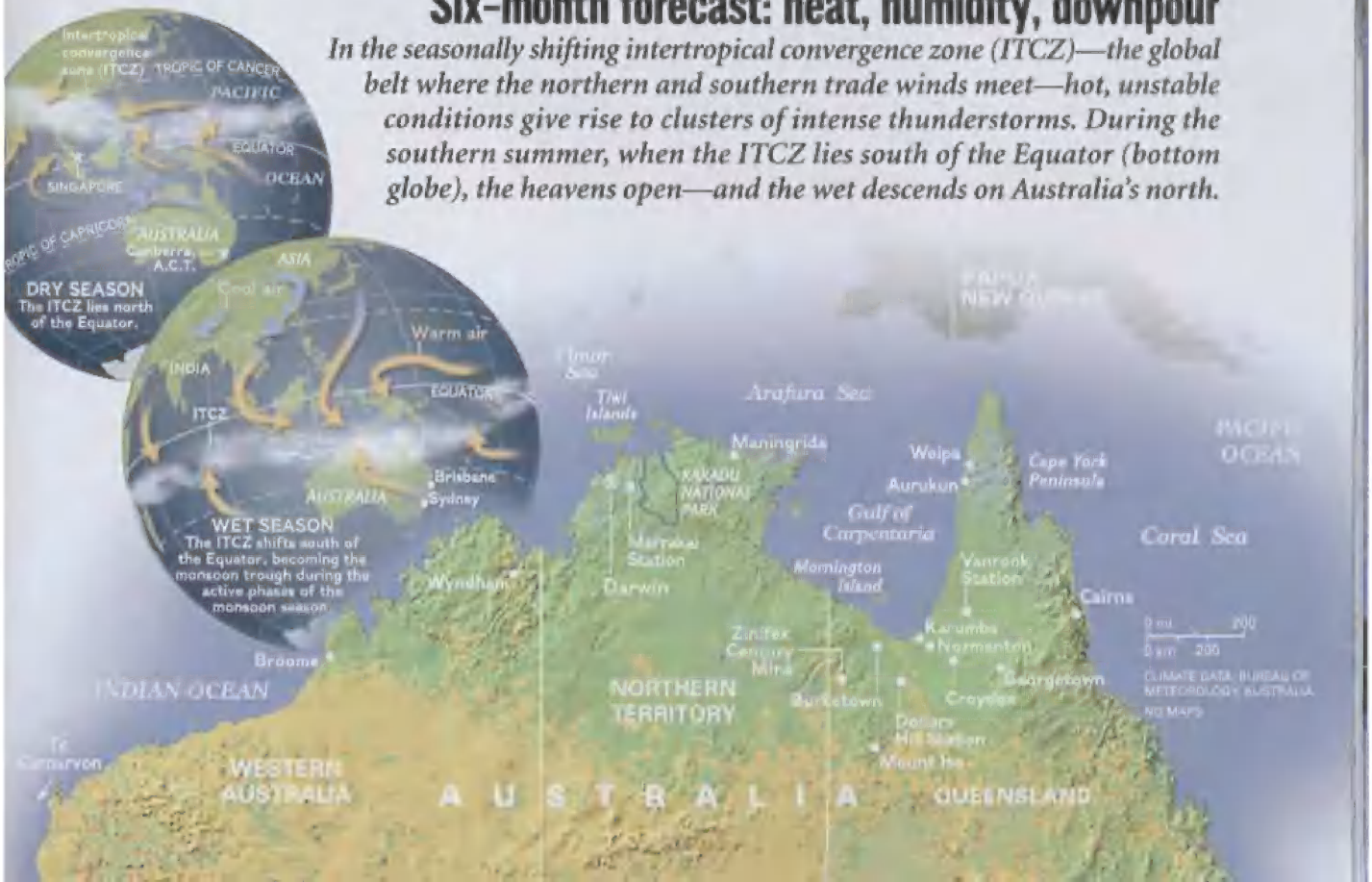
Yappar Street, a Week Later

One hundred and seven degrees in the shade, rainless skies, and nothing moving at midafternoon except the mercury in the thermometer. Fishing was finished for the year, the boats hoisted out of the water for refits or to be dry-docked in their skippers' backyards, safe from cyclones. The fish factory and cold-storage warehouses had slowed to care-and-maintenance pace, while the local helicopter pilots—who'd been leading full and dangerous lives these past few months mustering livestock on the huge cattle stations—now had time hanging heavy on their hands, since the work needs to be wrapped up well ahead of the rains. Pilots and cowboys alike spent their afternoons tinkering with their machines down at the hangar or improving their bank shots at one of the pool tables in the Animal Bar.

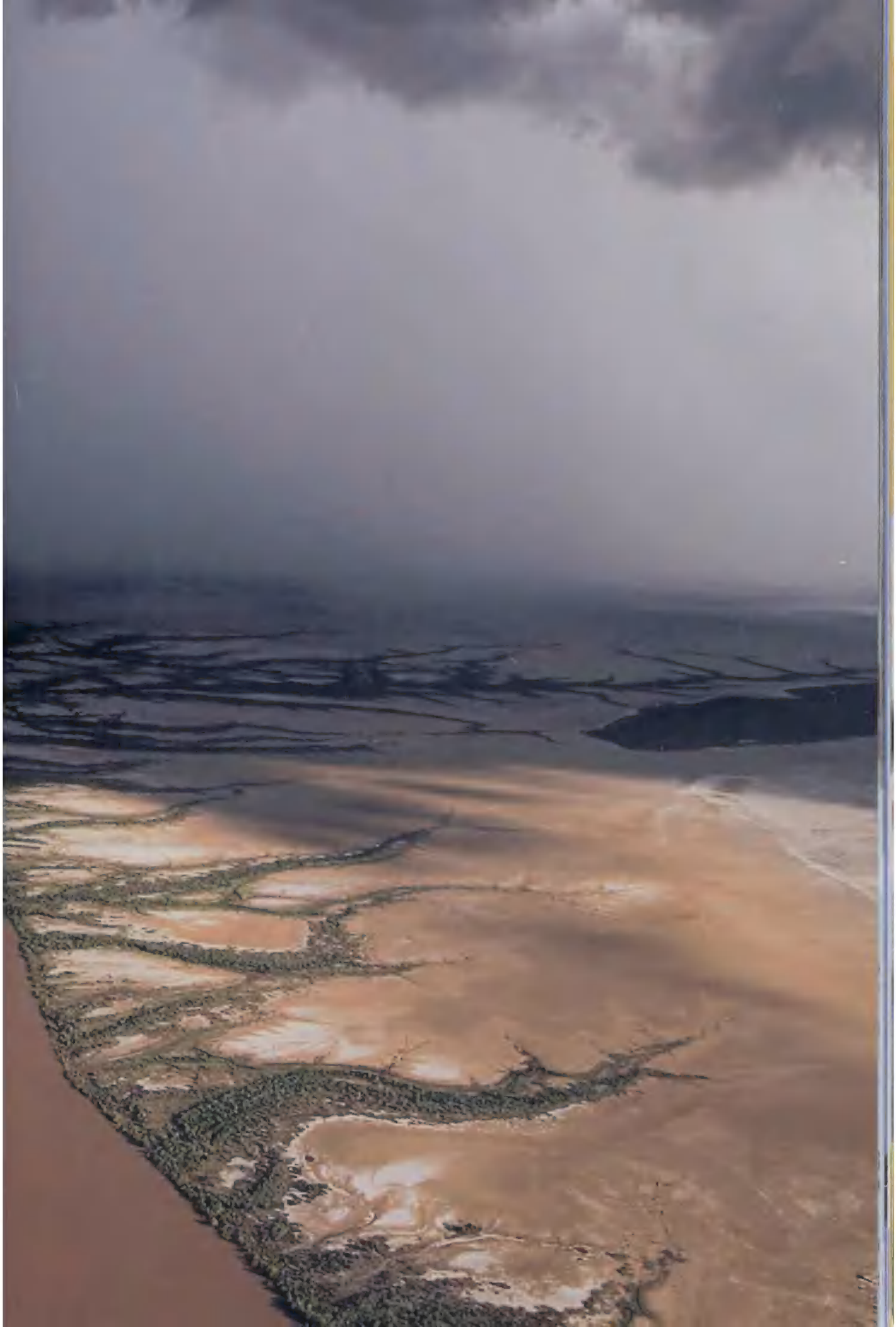
"This is the time of year when the women get bitchy and the blokes get into fights," Rob

Six-month forecast: heat, humidity, downpour

In the seasonally shifting intertropical convergence zone (ITCZ)—the global belt where the northern and southern trade winds meet—hot, unstable conditions give rise to clusters of intense thunderstorms. During the southern summer, when the ITCZ lies south of the Equator (bottom globe), the heavens open—and the wet descends on Australia's north.



"The rivers are always the color of creamed coffee, but especially after a storm," says Simon Graham, a pilot in Wyndham who criss-crosses silty waterways, gleaming mudflats, and mud-choked roads that can make ground transportation impossible during the wet. To stay airborne despite storm cells, Simon offers a tip. "Never fly into anything you can't see through."



Thomson, the engineer for the prawn trawler *Ocean Pearl*, told me. "The heat and humidity sends them crazy."

"Going troppo" is the local phrase for it; it's also called mango madness, since it all happens around the time the mangoes are ripening on the trees. A snippet I came across in a "Police Patch" column in another remote tropical town's newspaper says it all: "The weekend had its usual riots, beatings, and dangerous driving incidents, and the weather and mangoes seem to be bringing out the best in us all."

Here in Karumba the mango trees were fruiting nicely—Mick and his kids picked a wheelbarrowful in an hour in their backyard. Madness, happily enough, was in shorter supply. The town's two jail cells were unoccupied. For all its outward rough-and-tumble and the hard-drinking larrikins in the Animal Bar, Karumba is a good-natured little town, the sort of place where nobody locks their doors, everybody knows everybody else, and despite the odd Friday night dustup in the pub, people largely tolerate one another's foibles. It's a quirky combination of Mayberry R.F.D. and Cannery Row.

"What's the secret for getting through the wet?" I asked "Grandma," a sprightly 88-year-old who runs the town's busy thrift shop out of a corrugated-iron shed behind the café. I'd stopped in to browse her stack of old paperbacks, hoping to find a hefty potboiler to help kill the time. It was dying mighty hard.

"Go to the pub," she replied. "There's nothing else to do."

My question drew a chorus of jocular replies from the other browsers:

The dead men buried in Pioneer Cemetery were the city fathers who launched Broome's famed pearling business. Often lucrative, it was also risky: Two cyclones—in 1887 and 1935—each killed about 140 crewmen, who were buried down the coast where their bodies had washed up. Today, pearl diving still isn't for the faint of heart. Getting hosed down after a shift, Cheyne Pollard (left) cleans oyster beds 60 feet underwater for three hours at a stretch, often in muddy darkness brought on by runoff from the wet. "We feel our way around, which can be spooky," says Cheyne. "I don't like the sharks, or when my air supply goes wrong. But pearling is a good thrill."

"Send the wife to town—or go yourself."

"Go to the pub."

"Stay drunk."

"Good music, good food, and a good woman—but not necessarily in that order."

"Go to the pub."

At least there was always the weather to talk about. Somebody said a fellow from the "met office"—the Bureau of Meteorology—had passed through town a fortnight ago and proclaimed a 60 percent chance of a wetter than normal wet, with unusually good odds of a cyclone before Christmas, most likely in the gulf. This bit of news was explored, probed, turned over, and examined like an interesting pebble, and, ultimately, discarded. Outside the shop the sun flared overhead in a hot clear sky the color of old denim, and those stubborn southeasterlies continued to rattle palm fronds and tempers.

Scene Four

Going Bush

"Now I ask you, what good are green ants?"

"Well, you can eat 'em."

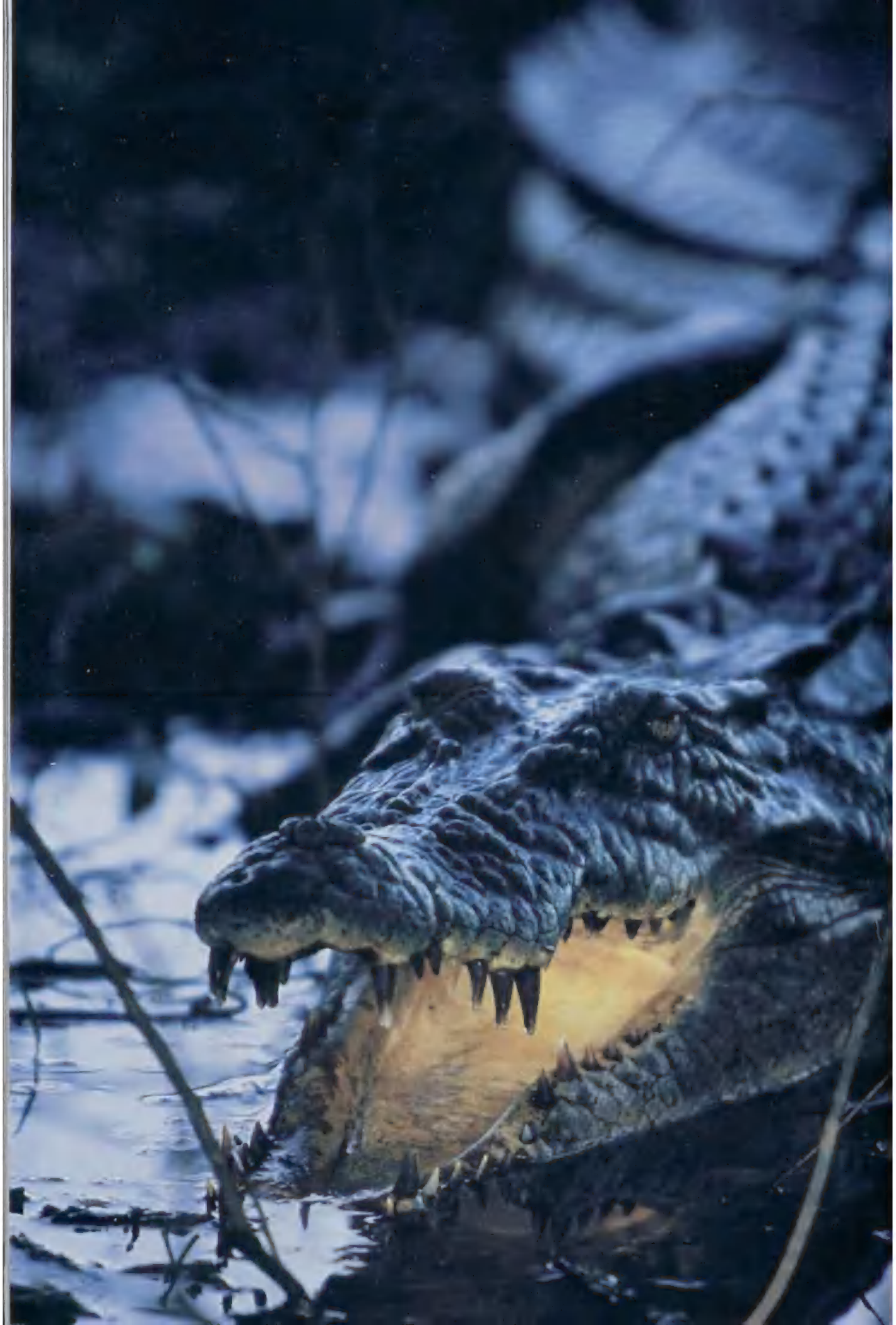
"All right, I'll ask again. What good are green ants?"

"Seriously, you can eat 'em. They're supposed to be very nutritious."

"Come on, mate, who's going to want to eat green ants if they can get anything better?"

"Maybe you can't get anything better. Maybe you're bogged out here in the wet, and you don't have anything else to eat."

"OK, OK—so except for a last-minute desperation menu item, what good are green ants? And why do they always have to drop on you and bite you every time you walk under a tree, for God's sake?"



A shaft of morning sunlight gives an incandescent glow to a saltwater crocodile in Kakadu National Park. From 1945 to 1971 commercial hunters decimated the Northern Territory's population of Crocodylus porosus, *but legal protection and careful management, including captive breeding during the wet, have boosted their numbers to around 70,000.*

"Why do mosquitoes give you Ross River virus? All part of the ecosystem, mate."

Policemen everywhere run to a fine line in deadpan irony and sarcasm—but when you add an outback setting and a pair of veteran bush coppers in full banter, you get dialogue with an almost Tarantino-like genius for the droll and offbeat. We were on "bush patrol." Mick and his partner, Senior Constable Jason Jesse, were making their periodic two-day circuit through the remote country along the Staaten and Gilbert Rivers, a hundred miles or so northeast of town, and I was along for the ride.

Only a few weeks ago there'd been the liquored-up pig shooters camped along the Gilbert River, letting off steam and rounds of happy-go-lucky, heavy-caliber rifle fire into the night; Mick and Jason had relieved them of their (unlicensed) firearms. And then there was the carload of mango-maddened yahoos from Mount Isa who had replaced a wheel on their broken trailer with a road sign one of them ripped down. They'd beerily sped along the Matilda Highway in a cloud of dust—the sparks from the metal igniting fires for the next 150 miles. "They thought it was a hoot."

But all was dead calm out here this time, nothing but the vast conspiratorial silence of the bush. In 400 miles we encountered nothing more suspicious than a cagey old crocodile basking on a riverbank; it slid partway into the murky water, eyed us for a few moments, and then slipped from sight. The only drunks we saw were rainbow lorikeets, a noisy flock of them, stoned on the overripe and fermenting fruit scattered beneath the huge mango tree that

Extending a toothy welcome, Andrea the Crocodile (right) was built in 1987 by vocational students in Wyndham, modeling their 66-foot-long creation on a real 12-foot saltwater croc. While they keep mostly to themselves, crocs have been known to attack unprovoked. In 2002 a 15-foot saltie killed a tourist taking a late night dip in a billabong. On the Adelaide River, tourists watch crocs snatch chunks of bait dangling from the boat. "We have about a hundred crocs in the area," says Tony Blums, who runs Jumping Crocodile Cruises. "The wet is breeding season, so the males are more aggressive, and that's exciting."

shaded the homestead at Vanrook Station. They chattered incessantly and chased their reflections into windows. Humans, it seems, aren't the only creatures around here susceptible to a touch of mango madness.

"You know, sometime before I leave the gulf, I'd like to come out here and spend the wet on one of these big lonely stations," Jason remarked as we rolled away from the Vanrook homestead. "Get flooded in."

"Yeah? And do what? Kill mosquitoes?"

"Contemplate."

"Contemplate what?"

"I don't know. Just contemplate."

Scene Five

Back in Town

My own long, sultry weeks of contemplation in Karumba dragged on through December, the monsoon seeming ever more like the proverbial watched kettle that refuses to boil. But by now at least storms were gathering. We could see them most afternoons, thunderheads curdling up to stratospheric heights over the savanna or out to sea, but they always slipped away, usually under cover of darkness, without dampening a single rooftop in town. News of capricious rainfalls in the region—an inch and a half at Mount Isa, 240 miles to the southwest, a like amount on Mornington Island, 110 miles out in the Gulf of Carpentaria, half an inch 90 miles away at Donors Hill Station—served to irritate rather than encourage.

One afternoon we were certain we were at last going to get that cracking thunderstorm we'd all been hoping for. Jason and I had been watching Australia and India play cricket on TV when a deep boom of thunder shook the house. Outside

Christmas Eve in Darwin, the Northern Territory's biggest city, isn't exactly rush hour. Once the wet splatters the far north, tourism takes a dive. "But there's still lots to do," says Mark Crummy, whose job is to lure visitors to the region. "The storms are spectacular. The waterfalls are thumping over. And it's a great time to take a scenic flight."

the skies to the south were purplish black, with wicked tongues of lightning dancing on the horizon and the maddening smell of desert rain carrying across the savanna.

"Who wants to go out and watch the storm roll in?" Jason called out, a suggestion his two little girls greeted with glee. His wife, Julie, put dinner on hold, and we all bundled into their big four-wheel-drive and headed out to the favorite storm-watching spot. As we rolled down the street, I noticed a good number of neighbors standing out in their yards, looking up. Once on the flats, we parked and arranged ourselves on the hood in an upbeat expectant sort of way that made me think of going to the drive-in. We'd even brought candy and nibblies,

grabbed in haste, for the show. The curtain-raiser was magnificent, but the main event never happened. The storm foundered before our eyes, breaking up as it neared Karumba. It was a gloomy ride back to town.

Normanton—an old river port about 50 miles upstream from Karumba—got about half an inch out of it. I know, because I happened to pass through there a couple of days later, and the woman behind the counter at the gas station told me about it—and wanted to know how much we'd had in Karumba.

"Not a drop," I muttered, surprised at the bitterness in my tone.

"Funny, it seems like Karumba always gets the rain, and it's almost always Normanton that misses out," she replied, as waspish as I and even a little accusatory.

"Really?" I said. "Well, that's not what I've heard."

"Well, it's true."

'Tis. 'Tain't. The mangoes were getting the better of us all.

I drove on back to Karumba in the afternoon heat, watching another spectacular mass of thunderheads performing a slow tease on the horizon. Christmas was coming up, and it was still dry in town, and the power lines by now so coated in statically charged particles of dust that even the briefest of midnight sprinkles was enough to short-circuit a transformer, start an electrical fire, and black out half the town. It happened the morning of the Christmas pageant. They held it anyway, out at the Sunset Tavern, where the Norman River spills into the gulf, and powered the show and the little merry-go-round with the portable generators canny townsfolk keep on hand in case of cyclones.

The pageant was pure Karumba; almost everyone turned up, and Mick acted as master of ceremonies. Santa was a lean, wiry, sun-browned trawlerman, with L-O-V-E and H-A-T-E tattooed on his knuckles and an enthusiasm that would have knocked any department store Santa I ever saw into a cocked hat. He strode up through the mangroves in his fur-trimmed red suit, hat, and boots, gloriously disdainful of the 109-degree heat (and the crocs too, for a nine-footer is said to lurk along that stretch of beach), while the town's children massed and chanted: "We want Santa! We want Santa!" And for the next hour or so he sat on a dais distributing presents and surreptitiously sipping beer. The schoolchildren put on a concert of lustily sung, Australianized carols, and a fragrantly smoky barbecue followed while a huge blood-red sun sank into the humid haze over the gulf. We drove home that night under a blaze of stars with that outback version of "Jingle Bells" running through our heads:

Dashing through the bush / In a rusty Holden ute
Kicking up the dust / Esky in the boot
Kelpie by my side / singing Christmas songs
It's Summertime and I am in my singlet,
shorts, and thongs
Oh! Jingle bells, jingle bells, jingle all the way,
Christmas in Australia / on a scorching
summer's day, Hey!


ADMISSION
ADULTS $13.50
CONCESSION $11.50
CHILDREN $8.50
FAMILY $39
MOVIE MONEY $110
STUDENT CARD ARE NOT ACCEPTED AS CONCESSIONS
SAVE OUR HISTORIC BUILDING
NO SMOKING
NO ALCOHOL
PERMITTED ON THESE PREMISES
SUN PICTURES
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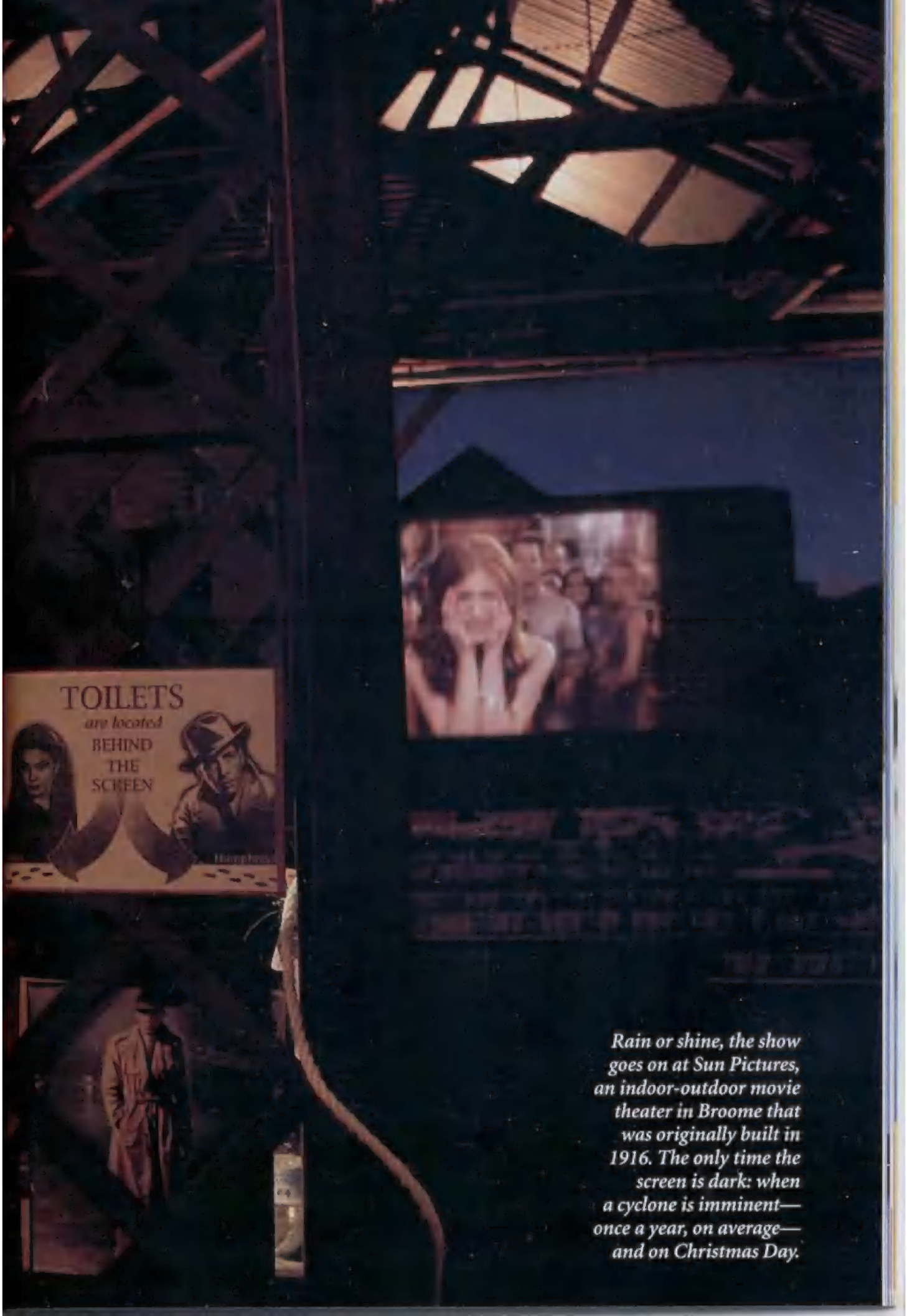


Rain or shine, the show goes on at Sun Pictures, an indoor-outdoor movie theater in Broome that was originally built in 1916. The only time the screen is dark: when a cyclone is imminent—once a year, on average—and on Christmas Day.

It continued to scorch for a fortnight, but then, in the season of giving, the first rains splattered our roofs. At long last the wet had arrived.

ACT TWO

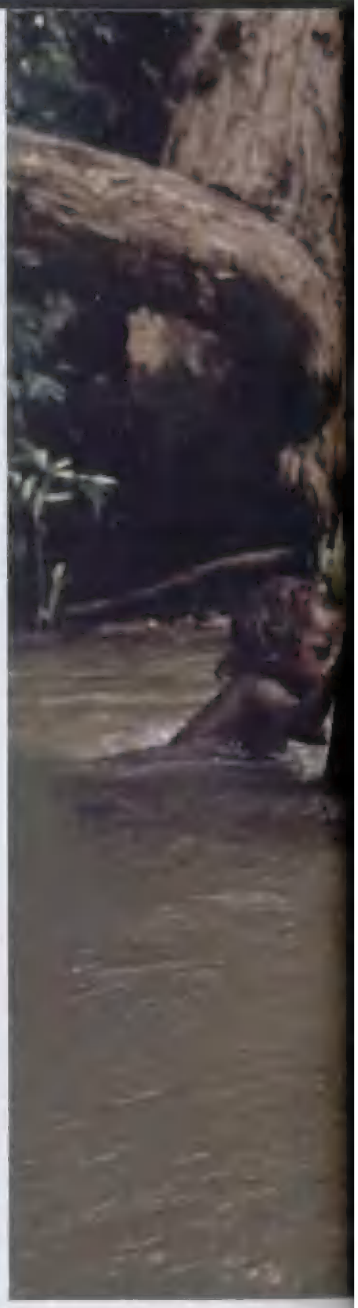
The Wet

Scene One

Yappar Street

Steam rising off the bitumen, the hard-green leaves on the mangoes and frangipani still glistening from the latest cloudburst, and the sun burning its way through the mist, making things feel hotter and steamier than ever. The only thing moving in town was a skinny old man, burned down by the sun, pedaling his rattletrap bicycle down the puddle-strewn road. He was barefoot, wearing only white canvas shorts and a floppy hat, which he'd decorated with a long plume of feathers. With his extravagant handlebar mustache and erect bearing, he made me think of some eccentric governor-general "gone native" in one of Queen Victoria's tropical backwaters.

They'd told me when I first came to Karumba that an Australian wet season was unpredictable. "It's not like those regular-as-clockwork rains you get in Singapore," an old hand had explained one night at the pub. "The wet can do anything, absolutely anything." And anything, it turns out, could also include those regular-as-clockwork performances they get in Singapore. As January —traditionally the time of the heaviest rains— gave way to February, Karumba remained for the most part bathed in hazy sunshine, the breathless afternoons punctuated by sudden sharp



When the heat is on, cool heads prevail in the Cadell River, where Vicky Brown, a ranger in the Aboriginal community of Maningrida, and her son Talvin Pascoe find midday relief. Experience tells Brown the crocodiles have moved downstream to nest, but she keeps an eye out. Gulping the overflow from a rain tank, Mick Jones, his wife, Kerriann, and daughters Jessica and Kacie celebrate the first big downpour in Karumba. "During the buildup, it gets hotter than hell, people stay up late, get cranky, and drink," says Mick, the local police sergeant. "I get bloody busy."

tropical showers that roared down for a few heady minutes, kicked up a dense rainy-gray mist on the main street, sluiced gloriously from the drainpipes—and then stopped as suddenly as if someone had turned off a faucet. The show was over for the day.

Still, it wasn't bad as wet seasons go—a foot of rain fell in January and almost as much the next month—and the rains were certainly quickening the landscape. Seemingly overnight the flatlands had bloomed into flowering wetlands—all silvery reflection pools, lush marsh grasses, banks of lily pads, and delicate yellow flowers. There were flocks of magpie geese, ibises, storks, and brolgas. The flooded terrain forced mammals such as wallabies onto drier, firmer ground, so that when we played our games of touch rugby at the park on Wednesday nights, we usually had an audience of bemused marsupials. Go for a drive at night, and the air would be so thick with flying insects, you'd feel as if you were driving through a snowstorm. The humans might be hunkering down for the duration, but the bush was going on a bender of feasting, growing, and breeding. One morning I just missed tripping over a stick insect that was nearly as long as my size-14 sneaker; one night I came across a pair of pythons copulating on the pavement.

But where was the drama foretold by those mountainous clouds during the buildup? The heavy dark monsoonal rains, the floods, the washed-out roads, the tropical cyclones? They were there all right. Everybody else across the top of Australia—from the remote iron-mining towns far in the west to Weipa, nearly 1,700 miles away on the upper part of Queensland's Cape York Peninsula—was getting a good old classic monsoonal wet. Burketown, 90 miles to our west,

was having one of its wettest wets in years, the road to the famously isolated town washed out for weeks, and supplies having to be airlifted from Mount Isa. Tropical Cyclone Debbie brought heavy rains and widespread flooding to the Northern Territory, while Tropical Cyclone Ken did the same for most of Western Australia, dropping nine inches of rain in four days over the drought-stricken Ellavalla cattle station near Carnarvon, more than the property had seen for the previous three years. And more wonderfully dark clouds were gathering across northern Australia as the wet gathered momentum.

Except here in Karumba, where we had our very civil afternoon sun showers.

Expectations rose briefly, then subsided again in mid-February with news that Tropical Cyclone Fritz was expected to swoop across the southern part of the Gulf of Carpentaria. Fritz had already drenched the Queensland coast and dropped eight inches of rain over Weipa, but the heart of the storm passed a hundred miles north of Karumba—and gave already well-watered Mornington Island another drubbing.

Mick and Kerriann and the rest of Karumba closely followed these happenings on the met office website. Up here the rains are like a paycheck: There is not only an interest in how much is falling on your own roof, but a lively and jealous curiosity about how much might be falling on your neighbor's as well.

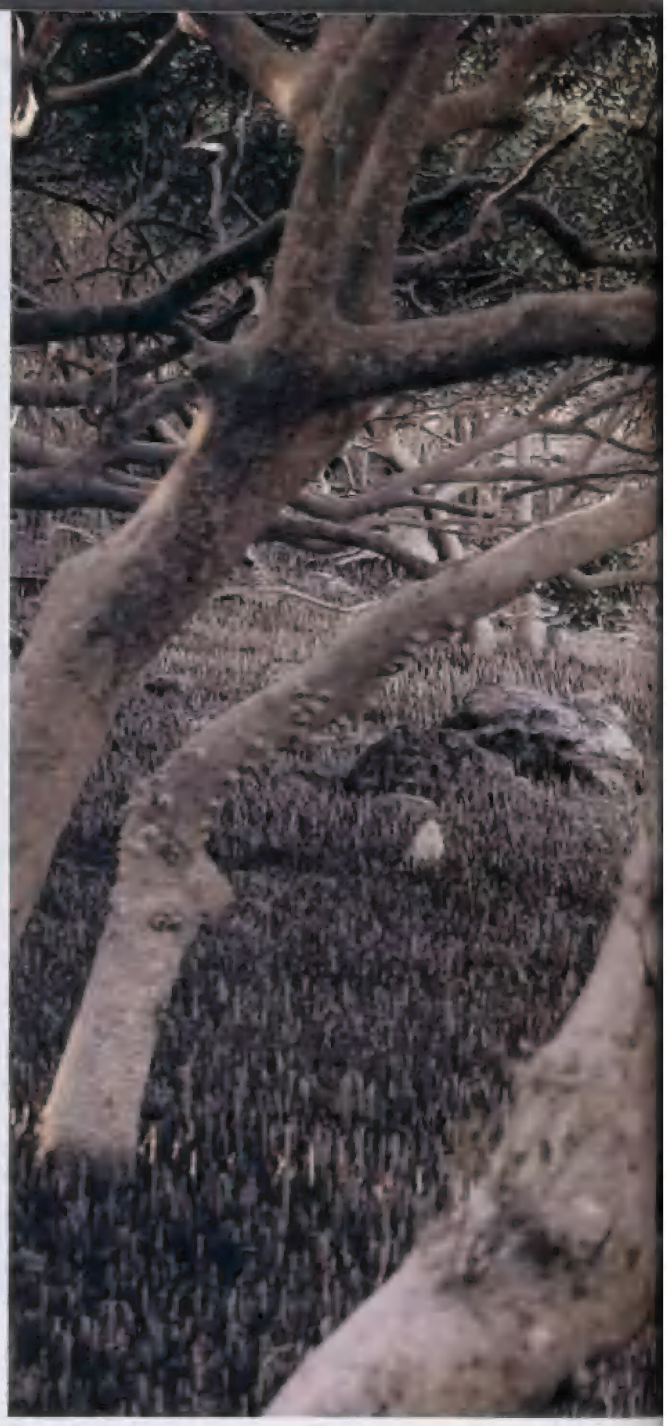
"Would you look at that!" Mick exclaimed, after he tapped the mouse over the Weipa icon: The screen had bloomed into a mass of pixelated yellows, greens, and plenty of pinks and reds, the colors of the heaviest tropical downpours. "The lucky bastards! They're always getting it. I hate to say it, but Weipa's where you ought to be going if you want to see some real monsoon."

Scene Two

At Sea

Nighttime on the riverfront, and a freighter—the M.V. *Warrender*—tied up beside a wooden wharf, waiting to slip down the river to the open waters of the Gulf of Carpentaria. Moths swirling in the lamplight, and the warm night air full of whirrings and chirpings from the tall grass as well as the restless hum of a forklift loading cargo onto the deck.

Mick dropped me off at the waterfront a little before nine, and I made my way to the wharf.



"I just hope it's going to be better up there than it was last week," a deckhand named Tyson said, as he showed me where to stow my gear. "The rain was coming down so hard you could barely breathe. We had about a foot of water sloshing around on the deck when we were trying to unload, which meant we couldn't see the slots on the containers for lifting with the forklift."

"Up there" meant Weipa, a town of 2,500 people, mostly mine workers and their families, tucked into a bay at the upper part of the Cape York Peninsula at the end of one of outback Australia's most challenging roads. It's a tough drive in the dry season; impossible in the wet. Since it's not feasible to airlift supplies to such a large town for months on end, the rain-stranded

Young Aborigines, like this girl hunting for mud crabs near Broome, inherit at least 50,000 years of wisdom about their homeland and its weather—how bird migrations, for instance, can help forecast the wet. It's a path of knowledge meteorologists are only beginning to explore.

community depends on weekly barges from Karumba—or all the way from Cairns, 400 miles southeast, if the trucks can't reach Karumba.

This year's been plain sailing, or at least as plain sailing as things ever get when it comes to resupplying a remote outback town during the wet. Every Monday morning a couple of road trains—those huge trucks, often triple-rigged, that rule the outback highways—set out on a lonely 1,400-mile trek from Brisbane, through the bush to Karumba, rolling onto the wharf on Tuesday night, where the *Warrender* is waiting.

That Tuesday, the deckhands cast off the lines a little after ten, and we glided down the river under a hazy gibbous moon, past the sleeping town and out into the gulf. The late-night jungly

chorus of insects and frogs on shore carried a surprisingly long way across the water.

"We've got everything aboard you need to run a small town," said Peter Hurley, the skipper. "Soap, razor blades, fresh fruit and vegetables, milk, toilet paper—you name it." There was also cargo for the mine and a shipment of blank ammunition for a jungle-warfare training exercise the army had penciled in for its special forces.

It's normally a 32-hour passage between Karumba and Weipa, but this run was slightly longer because Hurley decided to hug the coast to avoid squalls that were said to be kicking up a nasty swell farther offshore. "This thing rides like a pig in heavy seas," he said. Hurley, a former navy diver, has worked barge runs around the gulf for 15 years. "It can get really rough out here. The waves don't get as big as they do on the open ocean, but because the gulf is a fairly shallow body of water, they have a wickedly short wavelength and can absolutely hammer you."

We had a relatively smooth run as far as the swells went, although we met a torrential wall of rain the second night. It tapered off by morning, and when we drew into Weipa at dawn, the air was still and muggy, and the glassy surface of the bay simmered in the heat. The crew of the *Warrender* got their wish: The rain held off while they unloaded their cargo, but it thundered down again all that afternoon.

Scene Three

Far North

Here at last, in Weipa, was the wet I'd been looking for—the lush growth along the shore, the brooding thundery skies, the heavy curtains of

Holding on while trying to let go, Edwina Brooks leans on a pukumani *pole beside her father's grave at Garden Point in the Tiwi Islands. The pole, carved by Edwina's relatives, is part of a mortuary ceremony that occurs about a year after a burial. A mourner participating in the ceremony, which is designed to usher the dead soul to the spirit world, applies yellow ochre to his body (left) to disguise himself from the deceased. Though most major Aboriginal ceremonies are held during the dry, when traveling is easier, Edwina and her family ignored cyclone warnings to bid her father farewell.*

rain. Nearly three feet of rain had fallen here in the past month, and more drenchings were on the way. "All this can get to be really depressing," a woman named Lorisa Morgan told me one morning when I dropped by the community center and thrift shop. "You get so tired after a while of mold growing on everything. You want to go out for a nice dinner? First you have to clean the mold off your belt and shoes. We have to store our videos and computer disks in the refrigerator to keep the mold from ruining them.

"But at least there's one nice thing about it," she joked. "All the rains drive the ants indoors, and they scare away the cockroaches."

After the first couple of days, I found myself thinking of that old adage: Be careful what you wish for—you might just get it. I'd wanted to be flooded into a remote tropical town, and now, like locals who'd spent months looking forward to the rains, I was growing restive.

Lorisa put me in touch with an exterminator who was planning on driving to Aurukun, a settlement about 50 miles down the coast, as the frigatebirds fly. I called him up. "I've got a job down there," he said. "Leaving in the morning, should be back late tomorrow. Want to come?"

I was only too glad. Three days in Weipa, and I was already weary of the local watering holes—none of which quite managed the hard-boiled cheer of the Animal Bar. There was nowhere to go in town, and the fact that I couldn't leave by road—or so I'd been told—only made me want to drive somewhere. Here was my chance.

I spent the rest of the afternoon in the bar of the Weipa Bowls Club, drinking beneath a softly whirring ceiling fan with a few old hands: gruff, beer-gutted, craggy-faced men who'd between them put in about 150 wet seasons up here on

John Gostelow, a lifelong cattleman, says it every year: "Looks like we're going to have a good wet." Which means steady, regular rains, not biblical-scale floods. But John's mantra, says his wife, Nancy, isn't a prediction as much as a prayer.

the cape. One of them said he'd heard that Aurukun got four inches of rain overnight.

"I'm heading down there tomorrow," I said.

"Yeah? How're you planning on getting there?"

"We're driving." Noticing the amused skepticism on his face, and not wanting to appear too naive, I mentioned the exterminator who'd offered me the lift, and who was, I knew, a popular local with plenty of bush experience.

"So Mike reckons he's going to make it through to Aurukun, does he?" The man sipped his beer thoughtfully, then shrugged. "Well, it ought to be an interesting day out anyway."

"Short" and "illustrative" might have been better adjectives. We got as far as Myall Creek, about 40 miles out of town, where the muddy track disappeared into a black swirl of water and reappeared on the opposite bank, perhaps 50 yards away. Mike climbed out of his truck to assess the situation. "There's a bridge in there," he said after a moment. "It's not too far underwater, I don't think—maybe only three feet, and if I kept the wheel perfectly straight, I reckon we could probably make it across. But what worries me now, looking at how that current is undercutting the bank over there, is that I'm not at all sure the bridge is connected to the other side anymore. What do you reckon? Back to town?"

We drove home in a pelting rain.

ACT THREE

The Dry

Scene One

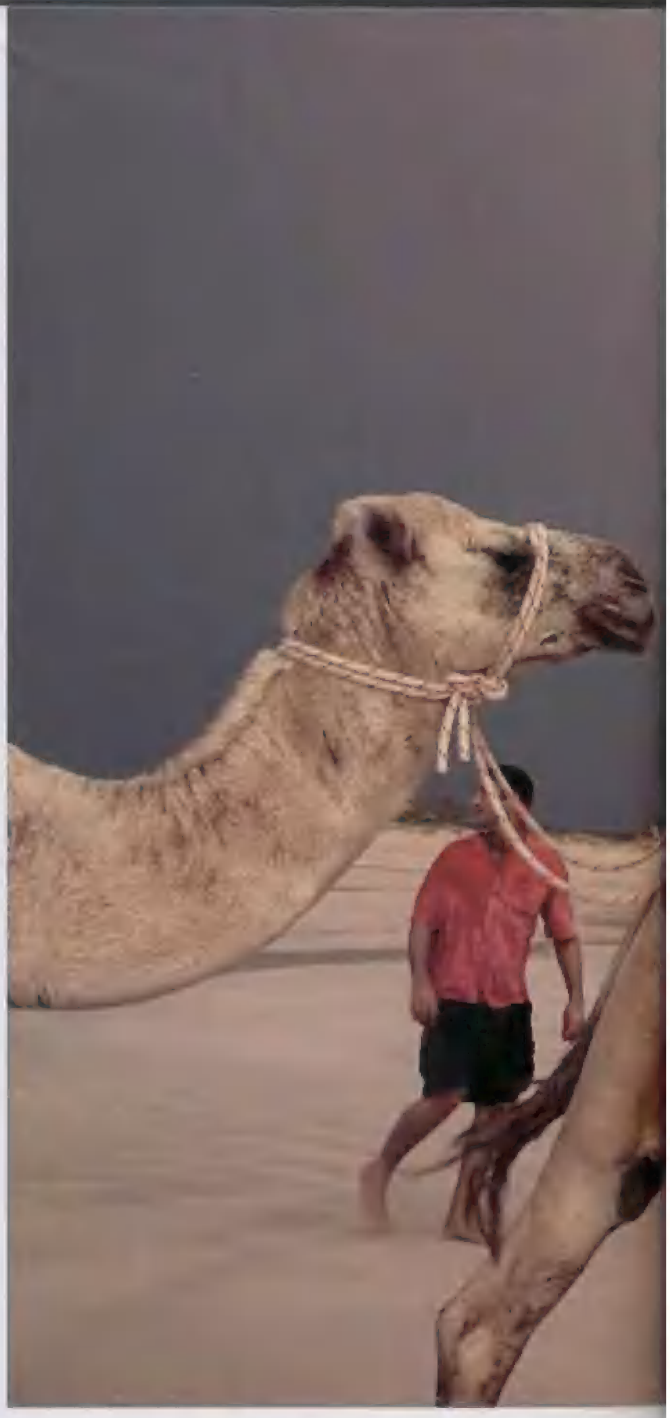
Karumba

"Those old southeasterlies are really starting to blow," Mick said, speaking to me by cell phone from the veranda, while I sat looking over the cool gray skies back home in South Australia. "We're freezing up here—it was only 25 degrees [77°F] when we went out on bush patrol the other day, and bloody cold at night."

Yappar Street in May, I learn, is unrecognizably busy, the boat ramp crowded, the motels and trailer parks full, the Sunset Tavern doing a roaring trade. For hard on the wings of the magpie geese comes the other great winter migration: that of the "gray nomads," the adventurous retirees who flock to Karumba with their trailers for the warm, dry-season winters, the barramundi fishing, and, not incidentally, the Australian government's remote-area tax breaks.

"It's like your favorite reality TV show down by the boat ramp," Mick said. "Everyone trying to get in ahead of each other, nobody knowing what they're doing—yelling, squabbling, punch-ups. We had one old guy die of a heart attack as he was backing his boat into the water. One minute he's looking forward to a day's fishing, next thing he knows he's knocking at the pearly gates. Not a bad way to go when you think about it."

It seemed a world away from the hot drowsy



GOING TROPPO: CROCS, MUD, AND THE WET

Share life on assignment with photographer Randy Olson in a multimedia feature, then enjoy more photos and send a "mango madness" postcard at nationalgeographic.com/magazine/0411.

steamy place I remembered. Every season has its time, but I like to remember Karumba as it was toward the end of the wet, the day Mick, Kerri-ann, the kids, and I took a drive out onto the flats to see the birds, the water lilies, and the silvery pools reflecting skies already starting to clear.

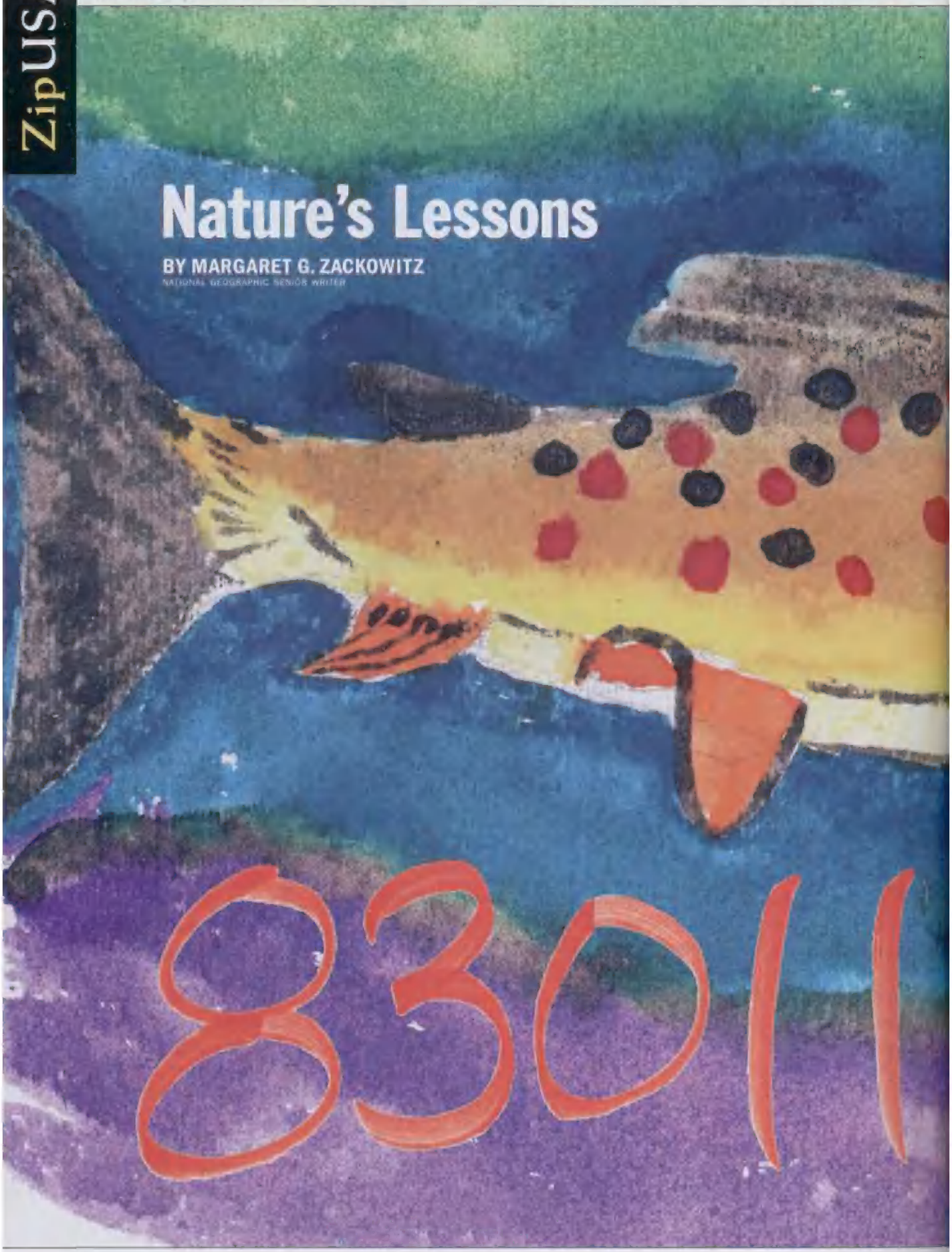
The girls wanted some of the pretty flowers on the lilies, and so Mick pulled off the road. "I sure hope there's no crocs in here," he laughed, a little uneasily, as he waded into the thigh-deep water and sloshed 20 yards to a mass of flowering lily pads. He picked two bouquets of delicate yellow and white flowers and brought them back to Jessica and Kacie. "Here you go, sweethearts. But we've got to be careful with these—enjoy them while we can; they won't keep." □

The sky might glower ominously, but if it's not pouring on Broome's Cable Beach, the tourists ride again. "Otherwise my camels get fat," says John Geappen, who runs these mini-caravans. Despite plenty of reasons to dread the monsoon, residents of Australia's tropical north remain spellbound by the wild storms and the new growth they bring. "The wet," says John, "is a magic time of year."

KELLY, WYOMING

Nature's Lessons

BY MARGARET G. ZACKOWITZ
NATIONAL GEOGRAPHIC SENIOR WRITER



118 From watercolors (above) to water testing (right), from hiking to haiku, the curriculum at the Kelly campus of Wyoming's
At TSS students learn about the world around them by spending their days tromping, splashing, or snowshoeing through

The mountains are the textbooks at Teton Science Schools; supplementary reading includes trees, wildlife, and weather. It all started back in 1967 with a plan for a summer-only tent camp teaching field ecology to local kids from Jackson Hole. These days the schools' Kelly, Wyoming, campus operates out of a scatter of log buildings on the grounds of an old dude ranch in Grand Teton National Park. Every week or so, year-round, a bus will rumble down the sage-tufted road to school with a new cargo of residential students. They might be from here in Wyoming or from a suburb outside Baltimore. They could be eight years old, eighteen, or older. But they'll all be handed journals to fill with their own words and pictures, and they'll all learn something before they go home. It might be about the world. It might be about themselves.

IAN McGREGOR (ABOVE); PENNY DE LOS SANTOS (RIGHT)

n Science Schools takes a creative approach to environmental education. erness. And the evenings? They spend them exhausted.

KELLY, WYOMING

83011

POPULATION: 240
STUDENTS TAUGHT BY TSS IN 1968: About 20
IN 1974: 150
IN 2004: 8,500
DON'T BRING: Video games, music, makeup
DO BRING: Hiking boots

Some cabins on campus don't have running water, but they do have a beautiful view. The log huts (left) are home to graduate students in TSS's 12-month graduate program. Visiting groups stay in slightly more luxurious digs—with bathrooms. TSS grad students pursue studies in environmental education while gaining practical teaching experience taking schoolkids out in the field. Among those they teach: some 30 annual participants in Jackson Hole High School's art and literature workshop. What they come home with from TSS can surprise even those closest to them. Said the father of the author of "Bluebird Days" (left), "Ian writes poetry?"

Bluebird Days

The blinding blue blanket
The whispy white wash
A Contrast of cold proportions
A dead hand reaches from
the downy snow
The last stretch of a sagebrush
The final, frozen gasp of air.

SUE PERIN (INSET); JEAN ARMOUR LEWIS (ABOVE); ART BY LYDIA TAYLOR; POEM BY IAN McGREGOR

Student artists find inspiration at TSS Murie Museum. Its collection includes more than 3,000 preserved animal specimens, including birds (right), gathered by naturalist brothers Olaus and Adolph Murie during their early wildlife surveys of Alaska and Wyoming. After Olaus's death in 1963, his wife, Margaret "Mardy" Murie, continued her work as a nationally known conservationist and author. Murie joined the schools' founding board in 1967. She died last year in her home near the campus at the age of 101.

Though still the nonprofit Murie helped start, TSS is now a multimillion-dollar operation, dependent on tuition fees and fund-raising to support its programs. A name change this year to the plural—Teton Science Schools—reflects a new campus under construction in Jackson, which will house a conservation center, a teaching institute, and a full-time school.

PENNY DE LOS SANTOS; BIRD ART BY JASON SCHECHTER; TREE ART BY ALI KORNBLUM

"Much of our day is spent on skis or snowshoes in the backcountry," says Jackson Hole High School teacher Greg Houda. He's a leader of the five-day art and literature workshop, which, says sophomore Ali Kornblum, has changed the way she sees the place she thought she knew. "Until you sit outside for a few hours by yourself," Kornblum explains. "You don't appreciate how great Wyoming is."

Ian McGregor, a senior, knows what Ali means. Like most local kids, he'd come to TSS often on field trips, even attended summer courses at the Kelly campus. When he realized this year's workshop would be his last student visit, he promised himself he'd return—as an adult. Ian says, "This place inspires you to do more than you thought you could." □

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SUE PERIN; TREE ART BY WILL SCHWARTZ; LEAF ART BY CAMILLE DAVIS

Final Edit

AUSTRALIA'S MONSOON

Winged Misery

An image of cattle tormented by swarming buffalo flies evokes the punishing climate of Australia's tropical north, where the insects proliferate soon after the torrential rains come. But while some photographs stand completely on their own, others work best in context. "An obvious pairing would be to run this picture with the cattleman on pages 92-3," says design editor Bob Gray. "We needed a strong human face for the opening text page, and we found it with the rancher's anxious look. But there wasn't room for both, and the cattle picture would not fit in as logically later in the story."

A different pest—the bush fly—caused plenty of annoyance for photographer Randy Olson. "They land on your skin and lick your sweat," he recalls. "As I was climbing an incline to photograph lightning, they walked in circles around my eyes, trying to get to the moisture below my eyelids. I had a camera in one hand and electronic equipment in the other, making it hard to shoo them away."

WEBSITE EXCLUSIVE

Cut it or keep it? Find out more about what tipped the balance for this photograph and e-greet a friend with it at **nationalgeographic.com/magazine/0411**.

WAS DARWIN WRONG?

Natural Selections

A photographer's view of evolution unfolds

When the subject of your assignment is evolution, "the problem isn't what to shoot," says photographer **Robert Clark** (above left, masked at a tuberculosis clinic in Siberia). "It's what not to shoot. There are endless options, a million ways to illustrate it." Rob chose to keep things simple. He picked a wide range of items he calls "pieces of evidence," then set up and lit each in the same way "to get a rhythm going—Exhibit A, Exhibit B—one related to the next." Clark shot with large-format film, which delivers intimate detail. An orchid. A feather. Pigeon bones. A naked mole rat. A primate's skeletal hand.

GNMENT

COVERING THE WORLD

"We distilled it down to basics, trying to make the images easy to read so the ideas they represent come clear," he says.

Taped side-by-side into an accordion, the Polaroids of the subjects—some with his notes along the edges—served as reminders of what had been covered and what was yet to come. "It's a reference tool for me, like a writer's notes, but visual," he says.

The subject Rob most enjoyed shooting? "The finches [lying flat, above]. Those are Darwin's birds! He handled them, studied them. It was those beaks on those birds that led him to think of new ideas, that made him wonder why."

NGS PHOTOGRAPHER MARK THIESSEN; PHOTOGRAPH OF ROBERT CLARK BY DAVID COVENTRY

AUSTRALIA'S MONSOON

Wet Season's Greetings

Fresh off an encounter with a crocodile, **Randy Olson** still dived into his work down under, wading up to his waist in a monsoon-swollen river to photograph some locals cooling off (above). But water wasn't everywhere for author **Roff Smith** (right), at least not at first. "If he could have shot holes in the clouds, he would have," Roff says of bush policeman and pal Mick Jones, far right, who had promised Roff a perfect storm. "The rainy season was fantastic elsewhere, just not where I chose to sit and wait for it," Roff says. So when the skies finally opened, "we got out of our cars and cracked up."

KERRY TRAPNELL (ABOVE); RANDY OLSON

WORLDWIDE

Time seemed suspended at the ancient Guatemalan cave of Naj Tunich for photographer **Stephen Alvarez,** who was invited there to document religious ceremonies. The cave has been used for rituals since at least 100 B.C. "Where the early Maya once worshipped, locals now venerate the same gods," he says. Stephen was a rare witness to what normally are private events. "I was amazed," he says, "at how they let me into the most sacred moments of their lives."

Swimming with mantas near Fiji's Great Astrolabe Reef gave photographer **Tim Laman** a thrill. "This huge shape would materialize coming right toward you. Sometimes it would be three or four mantas in a row," he says. "If I could go back to Fiji and dive at just one site, that would be it."

"I had solid walls and running water," reports **Maggie Zackowitz** of her Teton Science Schools lodgings. But not everyone in Kelly, Wyoming, is so fortunate. With housing costs in nearby Jackson Hole through the roof, some residents live in round white canvas tents called yurts. "They're scattered across a field like giant marshmallows," Maggie says. "Yurts are coveted as places to live, but I'll bet they're not so great when the snow piles up."

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Flashback

DAVID GOVE

WAS DARWIN WRONG?

Digging It

Finding mammoth tusks wasn't a mammoth task in Alaska in the early 1900s. Though extinct for some 10,000 years, woolly mammoths left a lot of themselves behind. Often prehistoric ivory was found poking from the snow, but this tusk hunter probably had to dig for his. In another unpublished shot from our archives, he stands between the tusks, gripping a shovel. Notes on the image say the bottom of the pit where the tusks were found was "covered with hair and small pieces of bones."

Many tusk hunters in Alaska and elsewhere sold their finds. A September 1907 GEOGRAPHIC article reported that in Siberia "there has been a regular export of mammoth ivory. More than 100 pairs of mammoth tusks have come into the market yearly during the last 200 years." They're still coming. Trade in mammoth ivory remains legal to this day.

—Margaret G. Zackowitz

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You can access the Flashback photo archives and send electronic greeting cards at **nationalgeographic.com/magazine/0411.**

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